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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

**LEASE VS. PURCHASE ANALYSIS OF ALTERNATIVE
FUEL VEHICLES IN THE UNITED STATES MARINE
CORPS**

by

Stephen J. Lebo
Robert M. Scott

December 2009

Thesis Advisor:
Second Reader:

William R. Gates
Donald E. Summers

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Having endured an economic downturn and impending budget cuts, should the United States Marine Corps (USMC) continue to lease the majority of its Alternative Fuel Vehicles (AFVs) from the General Services Administration (GSA) or should it consider purchasing AFVs as a viable option? This thesis will examine what, if any, benefits there are for the USMC to either purchase or lease AFVs. More specifically, it will attempt to determine what the USMC's optimal acquisition decision should be (lease or purchase) given potential changes in purchasing patterns over time. This analysis will afford decision makers the ability to make strategic financial decisions based on anticipated changes in the size of the USMC's Garrison Mobile Equipment fleet, as well as anticipated changes in market conditions regarding vehicle purchase prices, incremental costs, and salvage values. To answer these questions, this thesis will analyze historical data (2004 to 2009) for the largest populations of AFVs in the light-duty category and then apply a model that will compare the two alternatives based on their relative net present values. An aggregated view of several different light-duty AFV categories will then identify whether leasing or purchasing would be the most preferred.

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**LEASE VS. PURCHASE ANALYSIS OF ALTERNATIVE FUEL VEHICLES IN
THE UNITED STATES MARINE CORPS**

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ABSTRACT

Having endured an economic downturn and impending budget cuts, should the United States Marine Corps (USMC) continue to lease the majority of its Alternative Fuel Vehicles (AFVs) from the General Services Administration (GSA) or should it consider purchasing AFVs as a viable option? This thesis will examine what, if any, benefits there are for the USMC to either purchase or lease AFVs. More specifically, it will attempt to determine what the USMC's optimal acquisition decision should be (lease or purchase) given potential changes in purchasing patterns over time. This analysis will afford decision makers the ability to make strategic financial decisions based on anticipated changes in the size of the USMC's Garrison Mobile Equipment fleet, as well as anticipated changes in market conditions regarding vehicle purchase prices, incremental costs, and salvage values. To answer these questions, this thesis will analyze historical data (2004 to 2009) for the largest populations of AFVs in the light-duty category and then apply a model that will compare the two alternatives based on their relative net present values. An aggregated view of several different light-duty AFV categories will then identify whether leasing or purchasing would be the most preferred.

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TABLE OF CONTENTS

I.	INTRODUCTION.....	1
A.	BACKGROUND	1
B.	OBJECTIVE	2
C.	PROBLEM STATEMENT	2
D.	RESEARCH QUESTIONS.....	2
E.	METHODOLOGY	4
F.	ORGANIZATION OF THESIS	4
II.	BACKGROUND/LITERATURE REVIEW	7
A.	OVERVIEW.....	7
B.	EVOLUTION OF LEASING WITHIN THE DEPARTMENT OF DEFENSE	7
C.	CURRENT GSA LEASING/CONTRACT PRACTICES	8
D.	APPLICABLE LEGISLATION AND MANDATES	10
E.	ALTERNATIVE FUEL VEHICLES WITHIN THE UNITED STATES MARINE CORPS	13
F.	INCREMENTAL COSTS.....	15
G.	SUMMARY	17
III.	LEASING AND PURCHASING.....	19
A.	OVERVIEW.....	19
B.	PURCHASING.....	20
C.	LEASING.....	20
1.	Capital Lease	20
2.	Operating Lease	21
a.	<i>Wet versus Dry Lease</i>	22
D.	LEASING AND PURCHASING ADVANTAGES AND DISADVANTAGES	23
1.	Total Ownership	23
2.	Cost Realization	23
3.	Disposal Costs.....	24
4.	Salvage or Residual Value.....	24
5.	Interest	25
6.	Technology.....	26
E.	OTHER ISSUES TO CONSIDER WHEN DECIDING TO LEASE OR PURCHASE.....	26
F.	SUMMARY	28
IV.	THE MODEL.....	29
A.	OVERVIEW	29
B.	MODEL CONSTRUCTION.....	29
C.	ASSUMPTIONS.....	30
D.	SPREADSHEET FORMULAS	32
E.	SPREADSHEET INPUTS/VARIABLES	34

F.	SENSITIVITY ANALYSIS	42
G.	SUMMARY	44
V.	MODEL RESULTS	45
A.	OVERVIEW	45
B.	COSTS OF LEASING VERSUS PURCHASING	46
1.	Sensitivity Analysis #1: Salvage Value/Depreciation.....	46
2.	Sensitivity Analysis #2: Salvage Value versus Discount Rate.....	47
3.	Sensitivity Analysis #3: Changes in Incremental Costs for both Leased and Purchased Vehicles.....	48
4.	Sensitivity Analysis #4: Changes in Monthly Lease Rates versus Changes in Purchase Prices	51
5.	Sensitivity Analysis #5: Changes in Overall Fleet Inventory (Per Vehicle Type).....	52
6.	Aggregate.....	53
C.	SUMMARY	54
VI.	CONCLUSIONS	55
A.	INTRODUCTION.....	55
B.	CONCLUSIONS AND RECOMMENDATIONS.....	55
C.	SUMMARY	59
LIST OF REFERENCES		61
APPENDIX A: TYPES/DEFINITIONS OF ALTERNATIVE-FUELS		65
APPENDIX B: ENVIRONMENTAL PROTECTION AGENCY ACTS.....		67
APPENDIX C: USMC AFV FLEET SIZE		71
APPENDIX D: <i>OMB CIRCULAR NO. A-94</i>		73
APPENDIX E: NCCA INFLATION RATE INDEX/RAW INDICES		97
APPENDIX F: INCREMENTAL COST CALCULATIONS.....		99
APPENDIX G: MONTHLY LEASE RATE CALCULATIONS.....		101
APPENDIX H: VEHICLE PURCHASE PRICES		103
APPENDIX I: SENSITIVITY ANALYSIS/DATA TABLES.....		105
INITIAL DISTRIBUTION LIST		121

LIST OF TABLES

Table 1.	Minimum Vehicle Replacement Criteria (After: GSA, 2009 June)	10
Table 2.	USMC AFV Fleet as of FY 2008	14
Table 3.	USMC Light-duty Vehicle Inventory	32
Table 4.	Compact Sedan Baseline Calculations.....	
Table 5.	Pickup Truck (4x2) Baseline Calculations	
Table 6.	Minivan Baseline Calculations	
Table 7.	Initial findings of Benefit-Cost Analysis	45
Table 8.	Compact Sedans – Salvage Value.....	47
Table 9.	Compact Sedans – Salvage Value and Real Discount Rate.....	48
Table 10.	Compact Sedans – Incremental Costs (Lease and Purchase).....	50
Table 11.	Compact Sedans – Lease Rate versus Purchase Price	51
Table 12.	Compact Sedans – Changes in AFV Fleet Inventory	52
Table 13.	Aggregate Net Present Value.....	53

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LIST OF ACRONYMS AND ABBREVIATIONS

AFV	Alternative-fuel Vehicle
AMFA	<i>Alternative Motor Fuels Act</i>
APCAct	<i>Air Pollution Control Act</i>
CAAA	<i>Clean Air Act Amendments</i>
COBRA	<i>Consolidated Omnibus Budget Reconciliation Act</i>
CNG	Compressed Natural Gas
E-85	Ethanol-85
EISA	<i>Energy Independence and Security Act</i>
EPAct	<i>Energy Policy Act</i>
EO	Executive Order
FY	Fiscal Year
GSA	General Services Administration
GVWR	Gross Vehicle Weight Rating
HDV	Heavy-duty Vehicle
HQMC, I&L	Head Quarters Marine Corps, Installations & Logistics
IFMS	Interagency Fleet Management System
LDV	Light-duty Vehicle
LPG	Liquid Petroleum Gas
MDV	Medium-duty Vehicle
MOU	Memorandum of Understanding
NCCA	Naval Center for Cost Analysis
NDAA	<i>National Defense Authorization Act</i>
NPV	Net Present Value
OMB	Office of Management and Budget
O&M, MC	Operations & Maintenance, Marine Corps
PMC	Procurement Marine Corps
SUV	Sport Utility Vehicle
USMC	United States Marine Corps
WCF	Working Capital Fund

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I. INTRODUCTION

A. BACKGROUND

In the last two decades, leasing has become an increasingly popular method of financing. Today, many companies lease a significant portion of their assets, and this is particularly true for equipment leasing. The United States Marine Corps (USMC) is no different. The USMC currently leases the preponderance of its vehicle fleet, both gas burning and Alternative-fuel Vehicles (AFV), from the General Services Administration (GSA) Fleet. Its current fleet consists of 13,568 non-tactical vehicles, of which 2,868 are AFVs. Even though the GSA Fleet is currently the most cost-effective source of gas-burning vehicles and AFVs via the current leasing contract, the USMC may want to consider adjusting its acquisition strategy to include the option of purchasing vehicles as well.

There are three major reasons why purchasing vehicles may prove beneficial to leasing: incremental costs, salvage value, and anticipated changes in fleet size. First, there is an incremental cost associated with leasing AFVs. The incremental cost captures 1) the cost it takes to convert a given vehicle model from gas-burning to AFV and/or 2) the cost difference between the lowest-priced gas-burning vehicle in a given model/class and its comparative AFV in the same model/class. Second, there is a salvage value associate with purchasing an AFV. At the end of a lease agreement, the USMC simply returns the vehicle to the GSA, and the contract ends. When the USMC wishes to trade in or dispose of a purchased vehicle, there is an opportunity for the USMC to sell the vehicle and possibly recoup some of the total costs outlaid during its useful life. Lastly, the future is uncertain with regard to AFV demand based on the USMC's mission, as well as potential budgetary and fiscal constraints. Given these factors, the USMC may find it beneficial to purchase selected AFVs outright instead of leasing them. It is in this area between leasing and purchasing, specifically for AFVs, that calculations and analysis will be conducted to show the best course(s) of action for the USMC depending on the future projections of overall fleet size, incremental costs, and future salvage values.

B. OBJECTIVE

In this thesis, we will examine what, if any, benefits there are for the Marine Corps to either purchase or lease AFVs. More specifically, we will look at what the Marine Corps' optimal acquisition decision(s) should be (lease or purchase), given changes in purchasing patterns over time, incremental costs, and future salvage values. This type of analysis will afford decision-makers the ability to make strategic financial decisions based on anticipated changes in the size of the USMC's AFV Fleet, the type of vehicle to be leased or purchased and its associated incremental cost, and anticipated market conditions regarding salvage value.

C. PROBLEM STATEMENT

As the USMC is required to ramp up its acquisition of AFVs and further maintain a certain size fleet for the foreseeable future, there will be costs associated with their acquisition. Currently, the USMC leases the vast majority of its AFVs. These leases are tied to certain contractual term agreements—three to seven years depending on the vehicle type—after which the USMC is required to return the vehicles. However, there is no associated salvage value when it returns the vehicles. It simply returns the vehicles, loses all of the money associated with the lease payments, and receives no compensation upon return. As vehicles become more and more reliable, especially AFVs, and have longer service lives, it may prove less expensive to purchase an AFV, maintain and use it for more than three, perhaps even seven years, then sell it at the end of its useful life for a market-driven salvage value. As such, the problem that the USMC faces is whether to continue to lease AFVs, purchase them, or find a compliment between both alternatives in an effort to minimize costs.

D. RESEARCH QUESTIONS

The primary research question is the following: Is it more cost effective for the USMC to lease or purchase Alternative Fuel Vehicles for all of its future acquisitions? Subsidiary questions to be addressed in assessing the costs and benefits associated with leasing or purchasing AFVs are:

1. Given changes in salvage value/depreciation, what are the corresponding changes in costs between leasing and purchasing?

A vehicle's salvage value, or the rate at which it depreciates, affects its overall cost. Purchasing a vehicle is usually more expensive than leasing one; however, if the USMC can purchase a vehicle and sell it at the end of its useful life for a reasonable price, then there may be a possibility that it can recoup some of the overall costs and use that money for future investments.

2. Given Changes in incremental costs for both leased and purchased vehicles (both have differing values), what are the corresponding changes in costs between leasing and purchasing?

Incremental costs for both leased and purchased vehicles affect the overall costs of leasing versus purchasing a particular vehicle. Based on historical data, the incremental costs associated with leased and purchased vehicles can vary as a whole and are usually independent of each other; they are not necessarily the same for a given vehicle. The USMC has leased various types of vehicles and not all of them have had the same incremental costs. Additionally, the data has shown that these costs have ranged from \$0 to as much as \$5,000 per vehicle. These costs can play a significant role in 1) the decision to acquire the vehicle at all and 2) the cost of the vehicle and its value as an overall investment.

3. If the USMC wants to either increase or decrease its inventory of AFVs (based on current fleet size), what is the corresponding increase or decrease in fleet size that will shift the preferred alternative between leasing and purchasing?

This final question considers how potential changes in fleet inventory, or size, affect the overall costs to the USMC. The USMC's acquisition goals change each year based on budgetary limitations and needs of the gaining units and commands. Given these limiting factors, it is important to show how potential changes in the fleet size may affect the future costs of AFV acquisitions, for both leasing and purchasing.

E. METHODOLOGY

This thesis reviews the basic processes of the lease and purchase decision, specific rules governing leasing and purchasing, and the advantages and disadvantages of leasing and purchasing vehicles. The thesis will then examine the USMC's optimal acquisition decision given changes in anticipated salvage values, future incremental costs, and inventory size over time. To determine the optimal acquisition strategy, the thesis will examine data received from the USMC Commercial Vehicle Fleet Center and the GSA Fleet.

The largest population, or category, of AFVs in the USMC fleet is light-duty vehicles. Within this category, there are three major vehicle types: compact sedans, 4x2 pickup trucks, and minivans. This thesis will analyze these three vehicle types specifically, as they make up roughly 60% of the USMCs total AFV fleet. Various sensitivity analyses will compare the costs of both leasing and purchasing each vehicle type to determine the more preferred strategy and translate that to future decisions. A final aggregated view will potentially identify any overall biases towards leasing or purchasing.

F. ORGANIZATION OF THESIS

The research in this thesis is presented as follows:

Chapter I, Introduction, discusses the benefit, scope and methodology of this thesis while establishing context in the basic process of leasing and purchasing.

Chapter II, Background, provides a summary of all documents that were reviewed to gain the information necessary to present a thorough and informative thesis. It reviews the current GSA leasing contract and the applicable legislation and mandates that are driving the USMC to acquire more AFVs.

Chapter III, Leasing and Purchasing, briefly describes the two options in the acquisition process, leasing and purchasing. It also briefly discusses the difference between a capital lease, operating lease, and wet versus dry lease. It discusses the

advantages and disadvantages to both leasing and purchasing, as well as some issues to consider when decision-makers choose between leasing and purchasing.

Chapter IV, Model Assumptions/Inputs/Calculations, discusses the what, why, how and assumptions of the data used in calculations. It explains expected types of outputs and what those outputs will potentially represent as they relate to the comparison of leasing versus purchasing vehicles.

Chapter V, Model Results, analyzes the results of the model that was constructed in Chapter IV and the overall costs of both leasing and purchasing. It discusses the importance and meaning behind the results and how they can be used to develop a decision-making tool for the USMC to use when it decides to lease or purchase vehicles.

Chapter VI, Conclusions, provides the final analysis based on all related research and modeling. It will answer the initial research questions posed in this thesis and provide recommendations for future research and analysis.

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II. BACKGROUND/LITERATURE REVIEW

A. OVERVIEW

This chapter presents background information on several subject areas as a framework for discussing other topics raised throughout the thesis. Initially, it explains the evolution of leasing in the United States Marine Corps (USMC) and the current General Services Administration (GSA) leasing contract/model. The chapter then reviews various legislative documents that have acted as a driving force behind the acquisition and use of Alternative-fuel Vehicles (AFV) in the USMC. Next, the USMC's most current portfolio of AFVs is examined; along with their use as well as stated future requirements for AFVs. The final section presents a discussion on incremental costs, including their definition, why they exist and how they evolved, and how the GSA calculates them.

B. EVOLUTION OF LEASING WITHIN THE DEPARTMENT OF DEFENSE

The Department of Defense's mission and requirements have grown over the past few decades. With deployment cycles increasing and units facing 1:1 ratios of deployment time to dwell time, the USMC is required to conduct more training in less time. Unintended consequences of these norms have hit the recruiting operations especially hard. Recruiting and retaining the quantity of Soldiers, Sailors, Airmen and Marines needed to meet manpower goals has always been a difficult task, and with the increased operational tempo, it is getting harder and harder still. Between fleet units conducting additional training during hectic pre-deployment cycles and recruiters sometimes traveling great distances from their home station to meet with potential candidates, the need for and use of government vehicles has increased. In 2008 alone, the GSA Fleet purchased over 143,000 vehicles, with 22,000 of those being Alternative-fuel Vehicles. To date, there are almost 80,000 AFVs in the GSA Fleet's inventory. Ultimately, the GSA is required to convert their light-duty vehicle fleet to 75% AFVs.

Coupled with the increased vehicle fleet sizes and the AFV requirements, the GSA is also required to reduce petroleum consumption by 2% annually and increase alternative-fuel use by 10% annually (GSA Fleet, n.d.).

As the size of the GSA's vehicle fleet—as well as the USMC's vehicle fleet—has increased over the last few years, so have the acquisition, maintenance, and fuel costs of those fleets. To curb these increased costs, all USMC units were required to conduct cost-effectiveness studies to increase the efficiency of their government-owned vehicle transportation operations and management processes. Title XV, Subtitle C—Federal Motor Vehicle Expenditure Control, of *Public Law 99-272, Consolidated Omnibus Budget Reconciliation Act (COBRA)* mandated that the USMC take action to improve the management and efficiency of its commercially designated vehicle fleet to reduce costs of operation. As required by *COBRA*, in 1993 the USMC conducted a comprehensive and detailed study to compare the costs, benefits, and feasibility of 1) relying on the Interagency Fleet Management System (IFMS) of the GSA, 2) entering into a contract with commercial dealers, and 3) using any other less-costly, in-house means to meet motor-vehicle requirements. The study concluded that leasing through the IFMS is feasible, provides benefits that are equal to or exceed current motor-vehicle operations and is more cost effective when the USMC considers fielding AFVs, equipment replacement efficiency, and the expected quality of service to be provided (Jeu & Gray, 1996). The results of the *COBRA* cost-comparison study prompted the USMC to use the IMFS for all of its vehicle requirements and, subsequently, enter into the current Memorandum of Understanding (MOU) with the GSA for vehicles and support services.

C. CURRENT GSA LEASING/CONTRACT PRACTICES

The USMC leases the preponderance of its vehicle fleet—both gas-burning and AFV—from the GSA Federal Supply Service through the IFMS. This agreement is formalized in the MOU between the USMC and the IFMS GSA. The memorandum was approved on December 11, 1994, by the Deputy Chief of Staff for Installation and Logistics, Headquarters, United States Marine Corps (HQMC, I&L). The memorandum

approved the consolidation of selected Marine-Corps-owned Garrison Mobile Equipment vehicles with the GSA IMFS (Jeu & Gray, 1996).

The GSA Federal Supply Service operates the IFMS to provide and manage vehicles for use by federal departments and agencies and, specifically, the USMC. The IFMS has pooled federal assets, resources and expertise into a single interagency organization to reduce the size of the federal fleet and duplication of government fleet-management functions (Allan, 1993).

The vehicle management division of the GSA is broken down into two departments: the GSA Automotive and the GSA Fleet. The GSA Automotive is the mandatory source for purchasing federal-agency vehicles. The GSA Fleet is a full-service, fleet-management organization that provides vehicles to federal customers (such as the USMC) and is the mandatory source for leasing federal-agency vehicles. The leasing program offers complete management support for the vehicle's lifecycle. Fleet services include vehicle acquisition, asset management, maintenance and repair, fuel accident management, short-term rentals, and vehicle re-marketing (GSA, 2009 August).

The GSA Fleet determines the lease rates for vehicles based on the following formula:

Monthly Rate (Cost of Vehicle) + Mileage Rate (Fuel, Maintenance, Repairs) + AFV surcharge + Accessory Charge (for extra equipment and will not apply to all vehicles) = Total Monthly Cost

The accessory charge in the above formula includes non-standard equipment such as trailer or towing packages and tinted windows. On installed accessories, such as lift gates, winches, and snow plows, the GSA can complete the purchases and include the applicable charges in a lump sum. All equipment currently on GSA vehicles can be transferred to a new vehicle if the agency so chooses. The rates do not cover vehicle misuse/abuse, unauthorized purchases, accident damage, maintenance or replacement of USMC-owned equipment, dispatching, and driver services. The GSA will bill the USMC

for anything the rates do not cover. If an accident occurs, and the driver is at fault, then the USMC will be billed. If there is an identifiable third party, then the GSA will bill the third party (GSA Fleet, n.d.).

When an agency needs to replace a vehicle, the GSA Fleet adheres to and enforces the criteria outlined in Table 1.

Table 1. Minimum Vehicle Replacement Criteria (After: GSA, 2009 June)

Vehicle Type	Minimum Replacement Criteria
Sedan	3 years and 36,000 OR 4 years and any mileage OR Any years and 60,000 miles
Light Trucks 4x2 (gas)	7 years or 65,000 miles
Light Trucks 4x2 (diesel)	8 years or 150,000 miles
Medium Trucks 4x2, 4x4 (gas)	10 years or 100,000 miles
Medium Trucks 4x4, 4x4 (diesel)	10 years or 150,000 miles
Other Equipment	Varies

The GSA stresses that these replacement-cycle criteria are the minimums. The GSA's goal is to provide its federal customers, and specifically the USMC, with safe, modern and reliable vehicles for a competitive and cost-effective price. The current replacement cycle ensures this. However, if a particular vehicle is running and has no maintenance issues, the GSA may direct the agency to hold the vehicle for another year. Flexible replacement criteria allow the GSA to replace vehicles in the fleet that require rotation due to age, maintenance issues, and/or reliability issues and thus maintain a healthy and reliable fleet across the board (GSA Fleet, n.d.).

D. APPLICABLE LEGISLATION AND MANDATES

Due to legislation in the late 1980s and early 1990s surrounding the push towards energy efficiency and, more specifically, fuel efficiency, the Federal Government is now

bound by law to purchase and maintain a fleet of AFVs. This requirement is based on the *Alternative Motor Fuels Act (AMFA) of 1988*, the *Clean Air Act Amendments (CAAA) of 1990*, the *Energy Policy Act (EPAct) of 1992*, and *Executive Order (EO) 12759*. In addition, on December 13, 1996, President Clinton signed *EO 13031, Federal Alternative Fueled Vehicle Leadership*. In order to meet the acquisition goals of the *EPAct*, the USMC transferred funds to the GSA Fleet to pay the incremental cost of AFVs purchased for the USMC fleet (Jeu & Webster, n.d.). The agreement details the scope of work regarding acquiring and leasing AFVs and states that the GSA will:

Provide for the acquisition of AFVs for the USMC. On replacement vehicles, GSA will fund the base acquisition cost; e.g., an amount that approximates the equivalent price of a comparable conventional vehicle. GSA will lease these vehicles to the USMC at the prevailing conventional rates. GSA will acquire AFVs produced by original equipment manufacturer and will not convert gasoline vehicles to operate on alternative fuels. GSA will consider supporting infrastructure such as maintenance, repair and refueling in acquiring AFVs for the USMC bases. GSA will provide a report to AFV acquisition to the USMC that includes but is not limited to location, body type, fuel type, incremental cost and quantity of AFVs leased. (Jeu & Webster, n.d.)

A wide range of legislative acts, executive orders, and other federal documents passed (or amended) since 1955 guide the USMC's AFV acquisition. Based on these directives, the USMC is required to operate a fleet of AFVs and develop the necessary infrastructure capable of delivering the various alternative-fuels to sustain these vehicles. The overarching goal of these legislative documents is two-fold: 1) to loosen the nation's grip on the demand for foreign oil, thus improving national security and 2) to take measures to improve air quality through the reduction of petroleum-based emissions by conventional vehicles (vehicles burning fossil fuels).

It is important to understand the definition of an AFV, what type of fuel the law constitutes as being an alternative-fuel, and to whom and what size of vehicle these various laws apply to conduct a thorough review of the various legislative documents. The *EPAct of 1992* stipulates that an agency that "owns, operates, leases, or otherwise controls a fleet that contains at least 20 motor vehicles that are centrally fueled or capable

of being centrally fueled” is required by law to comply with the mandates if the vehicles are operated in a metropolitan area greater than 250,000 people (based on 1980 census data) (US Congress, 1992, Section 301). The specific size of the motor vehicle referenced is termed a light-duty vehicle (LDV) and has a Gross-vehicle-weight-rating (GVWR) of less than 8,500 pounds.

As for the definition of an AFV, one of its earliest derivations can be found in the *EPAct of 1992*. However, over time, its definition has been modified numerous times, with the most recent amendment coming from the *National Defense Authorization Act (NDAA) of 2008*. Paraphrased for ease of reading, the four types of vehicles that have been designated to fulfill the terms of the new AFV definition are as follows:

Any:

1. new, qualified fuel-cell motor vehicle,
2. new, advanced lean-burn technology motor vehicle,
3. new, qualified hybrid motor vehicle, and
4. any other type of vehicle that the Administrator demonstrates to the Secretary would achieve a significant reduction in petroleum consumption. (U.S. Congress, 2008, Section 2862)

Varied definitions for alternative-fuel can be found in multiple pieces of legislation. The most current definition is derived from the amendments of the *EPAct of 1992* (see Appendix A for a list of the various types of alternative-fuels and their definitions ((North Carolina Division of Pollution Prevention and Environmental Assistance, 2006, September)) and is defined as being made of:

methanol, denatured ethanol, and other alcohols; mixtures containing 85 percent or more (or such other percentage, but not less than 70 percent, [...]) by volume of methanol, denatured ethanol, and other alcohols with gasoline or other fuels; natural gas; liquefied petroleum gas; hydrogen; coal-derived liquid fuels; fuels (other than alcohol) derived from biological materials; electricity (including electricity from solar energy); and any other fuel the Secretary determines, by rule, is substantially not petroleum and would yield substantial energy security benefits and substantial environmental benefits. (U.S. Congress, 1992, Section 301)

Research reveals that there is an abundance of legislation that either establishes, defines, or enhances the laws that have been enacted to meet the goals of the United States. Over the years, these laws have laid out specific criteria and guidance for using AFVs and alternative-fuels within our government's fleet of non-tactical vehicles. In particular, this thesis will highlight only eight such documents since they seemingly have had the most impact on those federal agencies operating a fleet of vehicles.

Not included in the eight mentioned above, the *Air Pollution Control Act (APCAct) of 1955* was the launching pad that set the US Government on a course that would eventually recognize the importance of air quality and also take aim at accounting for the harsh consequences wrought by burning petroleum-based fuels. Since the passage of the *APCAct of 1955*, a series of legislative measures have worked their way through Congress and into the law books. These measures have contributed to, or have influenced, the way in which America regulates the current use of petroleum products and their impact on air pollution; however, not all of these legislative documents have played as prominent a role in the eventual use of AFVs in the USMC. In our opinion, the eight most significant documents includes the *CAAA of 1990*, the *EPAct of 1992*, *EO 13149 of 2000*, the *EPAct of 2005*, *EO 13423 of 2007*, the *Energy Independence and Security Act (EISA) of 2007*, the *NDAA of 2008*, and the *American Recovery and Reinvestment Act of 2009* (see Appendix B for the most important details of these acts as they relate to AFVs).

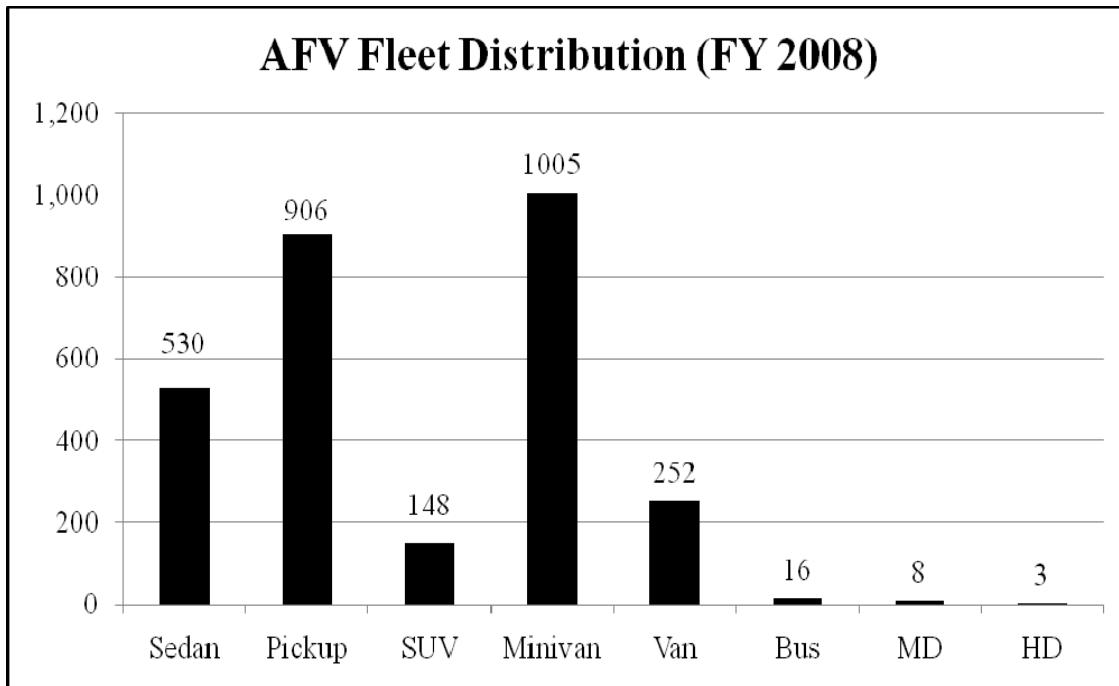
E. ALTERNATIVE FUEL VEHICLES WITHIN THE UNITED STATES MARINE CORPS

The USMC began its involvement with AFVs in the early 1990s as it strove to comply with federal legislation such as the *CAAA of 1990* and the *EPAct of 1992*. As of Fiscal Year (FY) 2008, the USMC's fleet of AFVs has grown to include almost 3,000 vehicles of various types and classes—all of which require at least four different kinds of alternative-fuels. This total represents a little more than 1/5 of the USMC's total fleet of non-tactical vehicles, which includes some 13,568 vehicles (USMC I&L, 2009, p. 3, 6).

Of the nearly 3,000 AFVs, the USMC's AFV fleet is predominantly comprised of LDVs, which have a GVWR of less than 8,500 pounds. In total, approximately 95% of the USMC's AFV fleet is the light-duty variant, while the remaining 5% is made up of primarily medium-duty vehicles (8,501-16,000 GVWR). As for the remainder of the USMC's AFV fleet, there is only a small number—approximately 0.001%—of heavy-duty vehicles (>16,000 GVWR).

To be more specific, the USMC's AFV fleet at the end of FY 2008 had a total of 1,005 minivans (35%), 906 pickups (32%), 530 sedans (18%), 252 vans (9%), 148 SUVs (5%), 16 buses (1%), 8 miscellaneous Medium-duty Vehicles (MDV) (0.01%), and 3 miscellaneous Heavy-duty Vehicles (HDV) (0.001%), for a total of 2,868 AFVs (see Appendix C for the detailed list of the USMC's AFV fleet at the end of FY 2008). Table 2 shows a graphical representation of the USMC's AFV Fleet, per major vehicle category, as of FY 2008.

Table 2. USMC AFV Fleet as of FY 2008



The fuel type of choice for the USMC's AFV fleet is Ethanol-85 (E-85). Of the nearly 3,000 AFVs in operation, 2,265 vehicles use E-85, which is just under 80% of the

AFV fleet. The remaining 20%, or 603 AFVs, use either compressed natural gas (CNG) or liquefied petroleum gas (LPG). In fact, AFVs using CNG take up the majority of the remaining 20%, with a total of 597 vehicles. This leaves only six AFVs that use LPG, which represents less than 0.01% of the AFV fleet.

“Flex-fuel” vehicles make up 80% of the USMC’s AFV fleet. These vehicles can use either E-85 or regular gasoline to refuel. The intent is to use E-85 whenever possible, but when it is not available, this added feature helps the USMC to meet its acquisition requirement and other legislative mandates as well as to increase the level of flexibility, utility, and ease of use for the operators of these vehicles. Additionally, “flex-fuel” vehicles provide the USMC with some additional time to build the necessary refueling infrastructure to support its AFV fleet.

The USMC’s AFV fleet is used to assist the conduct of day-to-day operations and to aid in supporting its mission. These operations require various modes of transportation to move passengers, cargo, or other multi-purpose requirements. Supporting these requirements, approximately 60% of the AFV fleet has been designated for transporting passengers, approximately 37% for transporting cargo, and the remaining 3% as multi-purpose.

The USMC plans to acquire some 527 various types and classes of AFVs for FY 2009, as well as approximately 410 for FY 2010 (USMC I&L, 2009, Appendix B, C). Even though the USMC has made plans to acquire roughly 937 AFVs through FY 2010, the *United States Marine Corps FY 2008 Alternative Fuel Vehicle (AFV) Report* does not mention how many vehicles will be replaced during this timeframe. In keeping with the USMC objective of increasing the use of alternative-fuels—with added emphasis on E-85 and the expansion of their alternative-fuel infrastructure—the vast majority of the planned AFV purchases will be the E-85 flex-fuel variant.

F. INCREMENTAL COSTS

The concept of incremental costs dates back to a time when auto manufacturers produced strictly conventional or fossil-fuel-burning vehicles. Since AFVs were not

made available directly from the manufacturer, buyers demanding an AFV had to incur the additional cost of sending the vehicle to a third party for modification. The payment that the third party received for performing the aftermarket conversion was often referred to as an “incremental” fee or charge. In the end, the buyer not only paid the purchase price for the fossil-fuel vehicle but also the incremental cost of having the vehicle converted to an alternative-fuel-burning vehicle. During this time, incremental costs were far more tangible in the sense that there was a specific cost associated with procuring a vehicle that had the acquired capability of using an alternative-fuel.

Prior to 1996, agencies operating a fleet of federally owned vehicles would receive additional funding in their operating budgets, designed to offset the incremental costs of complying with federal mandates requiring them to purchase AFVs. The adoption of *EO 13031* in 1996 effectively placed the burden of fully funding future purchases of AFVs—including incremental costs—on each individual agency.

Up to this point, the GSA, as a partner in the process of AFV acquisition and federal legislation compliance, possessed the latitude to charge its customers an “AFV surcharge.” The GSA could either 1) allocate, or spread, the AFV incremental costs across the agency’s entire fleet or 2) charge only the acquiring agency the AFV incremental cost per each vehicle acquired. However, the *EPAct of 2005* eliminated the GSA’s flexibility and dictated that it allocate incremental costs over an agency’s entire fleet of vehicles.

Auto manufacturers eventually attained the ability to produce AFVs via capital investment and numerous improvements in technology. As such, AFV customers no longer had to seek out a third-party organization capable of modifying their vehicle. However, eliminating the third-party organization from the AFV process inadvertently caused changes in the definition of incremental costs. The most significant change came in the form of a less tangible cost associated with bringing an AFV to market. Auto manufacturers’ actual conversion costs (gasoline to AFV) were difficult to identify. The GSA then developed a new AFV incremental-cost finance strategy to comply with the most recent legislation.

The method developed, and still in use today, is relatively straightforward. The GSA essentially lists or categorizes vehicles by size, but separates the cost based on the cheapest vehicle in each category. For example, if the cheapest car in a particular category is a regular gasoline vehicle with a cost of \$10,000, and the AFV in the same category is \$15,000, then the incremental cost for that vehicle is \$5,000. Essentially, there are many ways to calculate incremental cost and surcharges. Regardless of the method, the buyer ultimately pays whatever it costs the GSA to bring the vehicle to market—a cost that is much lower than suggested retail, given the steep discounts the GSA receives for buying in bulk.

How the GSA retrieves the cost of buying these vehicles and their associated incremental costs is far less clear-cut. The GSA conducts business using a Working Capital Fund (WCF). A WCF activity is required to breakeven (total revenues equals total expenses) on an annual basis. The GSA charges each of its customers a "surcharge" to ensure it generates sufficient revenues to cover its expenses. The surcharge rate is determined based on either those vehicles that are deemed "eligible" (according to government guidelines) or "covered" (vehicles that are required to meet specific government requirements for using alternative-fuels). The GSA allows for further flexibility in its surcharge rate by permitting agencies to pay a surcharge rate that covers either 100% of their eligible inventory, 100% of their covered inventory, or 75% of their covered inventory. Simply stated, the surcharge per vehicle is calculated by taking the agency's total estimated incremental costs for the year and dividing it by the number of vehicles in the agency's inventory. To get at the monthly rate per vehicle, the previous calculation is divided by twelve (GSA, 2006).

G. SUMMARY

This chapter established the framework from which to discuss leasing or purchasing AFVs. The evolution of leasing in the USMC and the current GSA leasing contract/model is based on an MOU between the two agencies as a result of legislation and public laws. Numerous EPActs and EO's passed in response to national and global environmental protection were the driving force behind the acquisition and use of AFVs

in the USMC. These external influences prompted all governmental agencies to quickly begin building their AFV fleets to ensure compliance. Consequently, the USMC currently operates a diverse array of AFVs and will continue to acquire more in the future. Of course, there is always a cost to acquire assets, and AFVs are no different. All costs considered, the USMC is still responsible to conduct its varied missions, and some of these require AFVs. As such, it is important, and will be even more so in the future, that the USMC carefully manages its scarce resources to effectively control these operations costs.

III. LEASING AND PURCHASING

A. OVERVIEW

The fact that the USMC's need for non-tactical government vehicles has increased due to operational requirements makes clear that the decision is not whether to acquire more vehicles; the decision becomes how to acquire the vehicles—via lease or purchase. Simply stated, the decision to either purchase or lease a vehicle depends on four major issues: 1) how the vehicle will be used (low versus high mileage and city versus highway driving), 2) the length of time the vehicle is expected to remain operational (3-5 years versus 6 or more years), 3) the incremental costs associated with the desired vehicle, and 4) the potential salvage value of the vehicle (only applicable if the vehicle is purchased). These four important questions form the basis from which the USMC can conduct its analysis and ultimately decide whether to lease or purchase a particular vehicle. Of course, to conduct a complete and more accurate cost-benefit analysis, the USMC must consider all of the criteria associated with leasing and purchasing and how they compare based on both quantitative and qualitative costs and factors. The *Office of Management and Budget (OMB) Circular Number (No) A-94: Guidelines and Discount Rates of Benefit-cost Analysis of Federal Programs* provide even more guidance on conducting a cost-benefit analysis of leasing versus purchasing an asset. *OMB Circular No A-94* is available in Appendix D of this thesis.

This chapter will describe the two alternatives the USMC can use to acquire non-tactical government vehicles from the GSA Fleet: leasing and purchasing. It will outline a brief synopsis of each process, starting with purchasing. It will then discuss the advantages and disadvantages of both leasing and purchasing. Finally, it will discuss some additional issues and questions that the USMC should consider when deciding whether to lease or purchase vehicles.

B. PURCHASING

Generally speaking, the act of purchasing involves the exchange of money (or an equivalent) for the legal ownership of a particular good or for the resulting output of a particular service being performed. More specifically, the Federal Government typically purchases fixed or capital assets (i.e., buildings, office furniture, computers, and, in the case of this thesis, vehicles) with the intent of retaining them for a long period of time. Determining when to replace an asset can depend on several factors; however, an asset is often deemed obsolete or marked for replacement when it has reached the end of its useful life.

The government's decision to either purchase or lease a capital asset is subject to the criteria printed in the *OMB Circular No. A-94* (see Appendix D for more information). In general, the decision to either purchase or lease an asset depends on which one costs less over the life or intended use of the asset. If the acquired asset will have a useful life beyond that of the terms of a lease, and the purchase cost is less than the cumulative costs of the lease, then the asset should be purchased.

C. LEASING

A lease is a written or implied contract by which an owner (the lessor: GSA) of a specific asset (government vehicle) grants a second party (the lessee: USMC) the right to its exclusive possession and use for a specific period and under specified conditions in return for specified periodic rental or lease payments. There are two broad types of leases: a capital lease and an operating lease.

1. Capital Lease

In a capital lease, the customer assumes some of the risks of ownership and enjoys some of the benefits. It is usually fixed-term and non-cancelable; the lessee is responsible for the payments for the life of the lease, regardless of whether the use of the asset has been exhausted. The lessor's services are limited to financing the asset, while the lessee pays all other costs, including insurance, maintenance, and taxes. Capital leases

are regarded as essentially equivalent to a sale by the lessor and a purchase by the lessee (even though the title remains with the lessor). To be considered a capital lease, a lease must meet one or more of these four criteria:

1. The title of the asset passes automatically from the lessor to the lessee at end of the lease term,
2. The lease contains a bargain purchase option, under which the lessee may acquire the leased asset at less than its fair market value at the end of the lease term,
3. The lease term is for a period longer than 75% of the estimated economic life of the asset, or
4. The present value of the lease payments is greater than 90% of the fair-market value of the asset at the beginning of the lease term.

A capital lease is a “full-payment lease” because the lease payments pay back (amortize) the full cost of the leased asset to the lessor, with little or no dependence on the residual (or salvage) value of the asset (“Capital Lease,” 2009)

2. Operating Lease

An operating lease is a cancelable, short-term (a period shorter than the economic life of the leased asset) lease written by the lessor with the intent to take back the leased asset after the lease term ends and release it to other users. The lessor gives the lessee the exclusive right to possess and use the leased asset for a specific period and under specified conditions, but retains almost all risks and rewards of ownership. Operating leases are commonly referred to as maintenance or service leases since the maintenance of the leased asset is usually the responsibility of the lessor. An operating lease does not meet any of the criteria for a capital lease (“Capital Lease,” 2009). To be considered an operating lease, a lease must meet all of the following criteria:

1. Ownership of the asset remains with the lessor during the term of the lease and is not transferred to the lessee, (government or USMC) at or shortly after the end of the lease term.
2. The lease does not contain a bargain-price purchase option.

3. The lease term does not exceed 75% of the estimated economic life of the asset.
4. The present value of the minimum lease payments over the life of the lease does not exceed 90% of the fair-market value of the asset at the beginning of the lease term.
5. The asset is for a general purpose rather than for a special purpose of the government and is not built to the unique specification of the government as lessee.
6. There is a private-sector market for the asset. (“*Capital Lease*”, 2009)

The USMC currently executes operating leases with the GSA for its vehicles. More specifically, it executes two types of operating leases: “wet” and “dry” operating leases.

a. Wet versus Dry Lease

A wet lease includes the price of fuel in the total costs, and a dry lease does not. The USMC exercises wet-lease contracts for the vehicles that are used in recruiting commands and dry leases for all other vehicles. The USMC, however, is looking to transition from dry leases to wet leases for all of its vehicles due to cost savings and the dynamic fuel prices experienced as of late. The decision to transition from dry- to wet-lease contracts was based on a study conducted in July 2007, entitled the *United States Marine Corps Fleet Management Study Report Task 3: Wet vs. Dry Lease Cost Analysis*. The analysis discovered that:

The dry lease is actually a “soggy” lease agreement, which means that one operating cost component is covered currently by a cents-per-mile charge: specifically, maintenance. Consequently, the key cost variable under the respective lease programs is fuel. Based upon the data collected during the study, the total cost differential between a dry and wet lease for the USMC is \$1,291,731.65 per year, a cost reduction of 6%, which yields a per vehicle average of \$293.36 per year. The analysis further recommends that the USMC develop a plan to implement a transition from a dry to a wet lease program. (USMC, 2007, July)

For the USMC to transition from a dry- to a wet-lease program, there are some implementation plan issues and considerations that must be taken into account. However, this thesis will not focus on these considerations since they do not relate to the lease-versus-purchase decision.

D. LEASING AND PURCHASING ADVANTAGES AND DISADVANTAGES

There are advantages and disadvantages for both alternatives—whether the USMC decides to either lease or purchase government vehicles from the GSA. It is imperative for the USMC to approach the decision with an unbiased point of view. The pertinent financial costs associated with leasing vehicles are compared to the financial costs associated with purchasing vehicles. Of course, these costs should be compared on an equal basis. The most common financial factors that affect the decision to lease or purchase are total ownership costs, cost realization, disposal costs, salvage or residual value, interest, and technology. This section will discuss the advantages and disadvantages of both the lease and purchase option as they pertain to these costs.

1. Total Ownership

Advantage: Purchase. One of the most significant advantages purchasing has over leasing is that the buyer assumes total ownership of the asset immediately. This attribute is noteworthy because the owner acquires and retains the right to use the asset without any restrictions (i.e., mileage limits, maintenance schedules, or vehicle alterations) at the time of purchase. In short, by obtaining outright ownership, the owner is granted the exclusive right to use the asset for the entire length of ownership.

Disadvantage: Lease. Under a lease agreement, the lessee is limited or restricted in the use of the asset throughout the duration of the lease. Leasing agencies intentionally restrict the use and modification of the asset to maximize the resale value of the asset.

2. Cost Realization

Advantage: Lease. Cost realization is one area in which leasing typically comes out ahead. When the buyer embarks on the decision to acquire an asset, the total or full

cost of obtaining ownership is realized up front. For example, purchasing a vehicle means that the customer pays for the cost of the vehicle, taxes, and any other applicable fees at the time of purchase. On the other hand, lease payments are derived from the vehicle's projected depreciation over the term of the lease, rental or usage fees, and taxes. Since you are not paying for the entire value of the car under a lease, the cost of obtaining the right to use the vehicle—subject to terms of use—is typically much less than the cost of an outright purchase.

Disadvantage: *Purchase*. As stated above, purchasing forces the buyer to assume all costs up front. However, it should be noted that if the benefits associated with acquiring total ownership are found to be greater than the reduced costs and limited terms of use, then realizing the full cost of ownership up front is more of an advantage than a disadvantage.

3. Disposal Costs

Advantage: *Lease*. Directly related to cost realization is the issue of disposal costs. The exception is that the discussion on cost realization emphasized the initial and enduring costs of ownership. In terms of disposal costs, these are the costs realized when ownership is no longer desired. The turnover of ownership often occurs when the asset has met the end of its useful life or becomes obsolete. In the case of a lease, the lessee does not bear this burden since they do not retain ownership.

Disadvantage: *Purchase*. Total ownership requires the owner to bear the full burden of any and all costs, including those costs assumed when the asset is resold or scrapped. In some cases, the actions to cease ownership obligations are both cost and time intensive.

4. Salvage or Residual Value

Advantage: *Purchase*. When the buyer purchases an asset and obtains total ownership, the buyer can recoup any remaining value that the asset might have at the end of its useful life. Any remaining value could possibly offset the initial costs of the investment or the cost of replacing the asset.

Disadvantage: Lease. As for a lease, since the lessee only pays for the limited use of the asset, he/she is not entitled to any of its residual value. As stated earlier, the leasing agency holds privilege since it retains ownership of the asset throughout the term of the lease.

5. Interest

Advantage: Purchase. In the absence of capital, agencies often use loans to purchase assets, and these loans incur interest. However, purchasing an appreciating asset via a loan can be worthwhile, given the future increase in wealth. On the other hand, purchasing a depreciating asset via a loan only leads to more costs over time and no ability to recoup invested monies. However, since this thesis applies to the US Government's acquisition of vehicles (a depreciable asset), the decision to finance the purchase of an asset, especially one that diminishes in value over time, is usually regarded as a poor investment since it deteriorates wealth.

In order to be thorough in the discussion of interest and to justify why the advantage goes to purchasing, it is necessary to draw a link between the government's purchasing guidelines and the potentially hidden costs of government purchases. Generally speaking, most fixed assets are purchased in full by the government at the time of the purchase to obtain total ownership of the asset. When this is the case, purchasing gains the advantage because the government avoids the added cost of interest payments. Although it is generally true that the government purchases assets in full, it is important to consider that the government has come to rely on financing an extensive portion of its purchases since its expenditures often exceed its revenues. Often, these additional costs are hidden or left out of the calculations when determining the true cost of a particular purchase.

Disadvantage: Lease. Even though a stream of lease payments is typically lower than the costs associated with achieving total ownership up front or via a recurring payment plan, lease payments tend to include additional fees that can mimic interest charges.

6. Technology

Advantage: Lease. When it comes to leasing—more specifically, the leasing of a durable asset such as a vehicle—typically the lease duration is relatively short (3 years). The advantage is that the lessee gets to benefit from advancements in technology on a recurring basis. Whether there are improvements in the safety of the vehicle, better gas mileage, increased reliability, or superior performance, the lessee is on the receiving end of many benefits that may be difficult to articulate in dollar figures.

Disadvantage: Purchase. For the purchaser, there are benefits similar to those obtained in a lease; however, the basis or time-interval over which these benefits are realized is more spread out. When the buyer decides to purchase a vehicle, especially one that is comparatively more expensive or is specialized in its functionality, the tendency is to retain the vehicle for a longer period of time (greater than that of a standard lease) in an effort to offset or spread out the costs. When this happens, the buyer forgoes some of the benefits derived from operating a newer vehicle.

E. OTHER ISSUES TO CONSIDER WHEN DECIDING TO LEASE OR PURCHASE

In most cases, the leasing or purchasing decision cannot be justified on the basis of financial considerations alone. Therefore, in a lease-versus-purchase decision, it is important to assess not only the impact of quantitative financial factors but also the impact of subjective and qualitative factors. The USMC should consider the following qualitative issues and questions to assess its current operating environment.

Operational Value

These questions examine an end user's need for new vehicles and the USMC's ability to manage a leasing contract.

1. Does the USMC have a formal replacement plan? If so, leasing is feasible. If replacement is done on an as-needed basis, the controls to manage a lease may be lacking.

2. Does the USMC currently lease any other type of equipment? If so, this experience can provide useful expertise for identifying the usefulness, benefits, and drawbacks of leasing.
3. Does the USMC have an operational need to replace vehicles more often than is currently done? If so, what is the largest obstacle to more frequent replacement?

Asset Management

The ability to know where all of the equipment is at a given point in time is crucial to lease management. Tracking only at aggregate levels does not allow the USMC to meet leasing terms when the time comes to identify and return the leased equipment. Penalties for lost/stolen equipment can add significantly to the cost of a leasing engagement.

1. Does the USMC have equipment-tracking mechanisms in place?
2. Does the USMC have a problem with lost or stolen equipment? If so, is this a small, medium, or large problem?

Contract Management

Effective leasing depends on the ability of the USMC to set up the lease properly at the outset, and then to manage the entire life of the leasing contract. Uncertain funding makes leasing much less feasible.

1. Does the USMC have the time to select a vendor?
2. Does the USMC have the time to develop a good leasing contract?
3. Does the USMC have the time and staff to manage the contract throughout the life-cycle of the equipment?
4. What is the stability of the primary source of funding for the USMC's vehicles? (Department of Information Resources, 1998, p. 8)

These are not the only issues that the USMC must take into consideration during the lease-versus-purchase decision-making process. However, as the USMC works through the benefit-cost analysis process, it will decide which relevant issues directly affect this process and which ones must be focused on.

F. SUMMARY

The lease-versus-purchase decision is an important one that must be made after exhaustive research and with a thorough understanding of the advantages and disadvantages of each option. Purchasing is a more appropriate option if the equipment will be used beyond the point in time when cumulative leasing costs exceed the purchase costs—assuming that the complete purchasing costs (including upgrades and maintenance) over the life of the purchase are known. Leasing, on the other hand, has many benefits that should be examined and considered as well. Leasing should be done when it is to the advantage of the government, primarily if equipment is immediately required to meet program goals that are not supported by purchasing the equipment. Also, leasing could allow for reduced overhead (infrastructure) and operating expenses, as well as lessen the need for long-term storage because of the responsibility of the manufacturer/owner for disposal. The USMC should thoroughly research and discuss these factors, among many others, prior to making the decision of whether to lease or purchase.

IV. THE MODEL

A. OVERVIEW

Lease-versus-purchase studies are essentially capital-budgeting analyses. The pertinent costs associated with leasing the asset are compared to the costs associated with purchasing the asset. Of course, these costs should be compared on an equal basis. We created a user-friendly model in Microsoft Excel to provide the USMC with a financial analysis of the lease-versus-purchase decision. The primary purpose of the model is to assess the economic feasibility of purchasing AFVs from the GSA Fleet instead of following the current policy of leasing AFVs from the GSA Fleet (Mollaghhasemi & Pet-Edwards, 1995). In the case of this thesis, our model will provide the USMC with a tool that compares the economic viability of leasing or purchasing particular light-duty vehicles. The model consists of two different versions or alternatives: lease or purchase. Both versions are similar, if not identical, in regard to layout, construction, and assumptions. They differ slightly in regard to a few of the inputs and variables. This chapter will discuss our model's construction, various assumptions, applicable inputs, and the use of sensitivity analysis to account for uncertainty and variation in future budget predictions and future market conditions, as related to salvage values and interest rates.

B. MODEL CONSTRUCTION

The model was constructed using a basic Excel spreadsheet that provides cost totals per year, based on the specific inputs for each alternative—lease or purchase. The model construction is fairly simplistic, given the assumptions and inputs assigned, which are discussed in subsequent sections of this chapter. Various inputs are linked in the model with equations, variables, and data tables where applicable. This format enables the user to observe how future costs can change by simply changing one or multiple inputs randomly or simultaneously—there is no need to adjust the construction or design of the model. Managers can use a model of this type to make decisions quickly, based on future market conditions and budget estimations, and to examine multiple scenarios

simultaneously. This section will not describe in detail the multitude of specific functions and equations associated with each variable and/or cell as they are basic, self-explanatory, and inherent within the model spreadsheet. As managers request to use this model, it can be made available via Excel.

C. ASSUMPTIONS

The following assumptions were considered while developing the model:

Definition of AFV (for model input purposes): The USMC and the GSA have differing opinions regarding what they consider to be an AFV. Given constraints in available data, only those vehicles with fuel types of E-85, CNG, and propane were considered in the model.

Historical Data: It is essential to compile the most thorough historical data possible to calculate the most accurate estimate of future costs. The data collected spanned from 2004 through 2009, with little data prior to 2004. Given insufficient data prior to 2004, the USMC's AFV fleet, for the purposes of this model, will include only vehicles leased or purchased after 2004. Based on this constraint, 2004 will essentially be time zero for the USMC AFV fleet. Similarly, when calculating the number of vehicles sold in any given year, only those vehicles sold after FY 2004 will be included in the AFV fleet. The data used for this model was provided by both the GSA Fleet and the United States Marine Corps Commercial Vehicle Fleet Center.

Inflation: It is essential to compile the most thorough historical data possible to calculate the most accurate estimate of future costs. The data collected spanned from 2004 through 2009, with little data prior to 2004. Given insufficient data prior to 2004, the USMC's AFV fleet, for the purposes of this model, will include only vehicles leased or purchased after 2004. Based on this constraint, 2004 will essentially be time zero for the USMC AFV fleet. Similarly, when calculating the number of vehicles sold in any given year, only those vehicles sold after FY 2004 will be included in the AFV fleet. The data used for this model was provided by both the GSA Fleet and the United States Marine Corps Commercial Vehicle Fleet Center.

Interest Rates: The GSA Fleet purchases all of the vehicles in its inventory and pays the vehicle's full price up front, incurring zero interest. Consequently, regardless of whether the USMC leases or purchases vehicles from the GSA Fleet, it is not charged interest since the GSA Fleet did not pay interest when acquiring the vehicles. Therefore, interest rates are not applicable for this model.

Lease Payments: The GSA determines lease payments based on the vehicle's purchase price. There are additional charges (i.e., a mileage rate that covers fuel, maintenance, and repairs), an AFV surcharge that covers the GSA's administrative costs, accessory charges that are designed to cover the cost of extra equipment (does not apply to all vehicles), and anticipated salvage values that directly impact the USMC's overall payment to the GSA. These charges were left out of the model in an effort to compare and contrast only those variables that appear to be dissimilar.

Mileage Rates: In an attempt to address the underlying issues that directly affect the cost of a lease or purchase of a light-duty AFV, we assumed that the costs incurred by the GSA to maintain its vehicles (which are recouped in the form of mileage rates) are the same as what the USMC would pay for maintenance if it owned the vehicles outright. Therefore, these rates are the same for both a lease and a purchase and were not treated as separate variables.

Vehicle Categories: There are many different types and sizes of vehicles that the USMC can either lease or buy from the GSA. They range from small, compact sedans such as Ford Fusions up to large 44-passenger buses. However, no matter the size of the vehicle, each falls into one of three broad categories: light-, medium-, or heavy-duty vehicle. Compact sedans, pickups, sport utility vehicles (SUVs), and minivans are all considered light-duty vehicles. Given limitations in the available data, the model focuses only on light-duty vehicles. Light-duty vehicles were found to be the most common and represented roughly 60% of the USMC's total fleet of non-tactical vehicles. In particular, the model incorporates only compact sedans, pickup truck 4x2s, and minivans. Table 3 shows the vehicle types used.

Table 3. USMC Light-duty Vehicle Inventory

Vehicle Type	Fuel Type	Fuel Capability	Total Inventory
Sedan, Compact	E-85	Flex-fuel	381
Pickup 4x2	E-85	Flex-fuel	414
Minivan (Passenger)	E-85	Flex-fuel	899

Wet versus Dry Lease: The USMC currently operates the majority of its vehicles' leases according to the wet lease (see Chapter II of this study for additional wet- and dry-lease information). Based on conversations with personnel at the USMC Commercial Vehicle Fleet Center, we learned that the USMC will eventually transition all remaining dry-lease vehicles to wet leases. Therefore, the model will only focus on data from vehicles operating under a wet lease.

D. SPREADSHEET FORMULAS

The following formulas were critical to the model and the overall analysis and provided the baseline upon which the lease and purchase alternatives were compared:

Annual Cost of AFV Inventory (Lease): This simply represents the total cost of all vehicles in the USMC fleet/inventory per year. The value is calculated by using the total number of vehicles in inventory, the annual lease rate for those vehicles, and associated incremental costs, if any.

Annual Cost of AFV Inventory (lease) = Number of Vehicles Acquired x (Inflation-adjusted Yearly Lease Rate per Vehicle + Inflation-adjusted Incremental Cost per Vehicle)

Annual Cost of AFV Inventory (Purchase): This value is calculated using the total number of vehicles purchased in a given year, the purchase price per vehicle, and the incremental costs of those vehicles, if any.

Annual Cost of AFV Inventory (purchase) = Number of Vehicles Acquired x (Inflation-adjusted Purchase Price per Vehicle + Inflation-adjusted Incremental Cost per Vehicle)

Inflation-adjusted Total Average Salvage Value per Year: Salvage Value is the estimated value of the vehicle upon resale and/or how much of its original purchase price is recouped in the sale. See Section E below for further discussion on salvage value and the assumptions used in the model.

Inflation-adjusted Total Average Salvage Value per Year = Number of Vehicles Acquired x (Inflation-adjusted Purchase Price per Vehicle + Inflation-adjusted Incremental Cost per Vehicle) x 0.25*

*0.25 is a salvage value factor and can be changed based on market-driven resale values.

Net Present Value (NPV) of Total Annual Cost of AFV Inventory: The concept of present value is important when the USMC makes an equal comparison of costs between leasing and purchasing options. Present value refers to the cost of future expenditures in today's dollars, after accounting for the time value of money (and inflation). A dollar that the USMC has available to use in the future is worth less than a dollar available today. When comparing leasing and purchasing alternatives, the future dollars you would expend (or receive in the case of salvage value) in a lease or purchase contract must be converted to their value in present dollars to compare the real costs of each option (Department of Information Resources, 1998, p. 3).

NPV of Total Annual Cost of AFV Inventory (Purchase) = Annual Cost of AFV Inventory (lease) x Discount Rate Factor*

NPV of Total Annual Cost of AFV Inventory (Purchase) = Annual Cost of AFV Inventory (purchase) x Discount Rate Factor*

*The Discount Rate Factor (and the Discount Rate in general) is explained in detail in Section E of this chapter.

NPV of Total Cost of Inventory, 2009 \$ (Lease): This is the total cost, in 2009 dollars, of vehicles acquired (leased) between 2004 and 2009. This is calculated by simply summing the NPV of Total Annual Cost of AFV Inventory for each year (2004–2009).

NPV of Total Cost of Inventory, 2009 \$ (Purchase): This is the total cost, in 2009 dollars, of vehicles acquired (purchased) between 2004 and 2009. However, unlike

leasing, this accounts for salvage value deductions as well (see Inflation-adjusted Total Average Salvage Value per Year calculations above).

NPV of Total Cost of Inventory, 2009 \$ (Purchase) = The sum of years 2004 through 2009 (derived from the NPV of Total Annual Cost of AFV Inventory—Inflation-adjusted Total Average Salvage Value per Year)

E. SPREADSHEET INPUTS/VARIABLES

The lease and purchase alternatives of the model contain many of the same inputs and variables. Rather than explain each alternative model and its associated inputs and variables separately, this section will explain each of these individually and state whether it applies to the lease alternative (L), purchase alternative (P), or both (B). This section will also explain why and how each was calculated, if applicable. For the purposes of this model, inputs are values based on available historical data. Variables are those values that can be changed based on future decisions by management, OMB mandates (such as discount factors), and the GSA's published rates and purchase prices. Variables can also be manipulated to forecast and predict future costs based on a manager's potential or anticipated changes.

AFV Inventory (B): This variable represents the total on-hand inventory each year, based on how many vehicles are purchased and/or leased and returned and/or sold by the USMC. Since the USMC has leased virtually all of its light-duty vehicles from the GSA, the inventory used for the purchasing alternative was the same as the inventory in the leasing alternative. This variable can be changed, given future acquisition goals of the USMC and future budgetary funding constraints.

Annual Cost of Inventory (B): This represents the total cost of all vehicles in the USMC fleet/inventory per year (see Section D for calculations).

Discount Rate (B): The discount rate represents an opportunity cost of capital—money that is spent to purchase or lease a vehicle is money that can no longer be used for alternate purchases or investments. By definition, the discount rate is the annual growth rate (interest) of an investment, used when a future value is assumed and one is trying to find the equivalent present value. *OMB Circular No A-94* (OMB, 1992) dictates what

discount rates, both real and nominal, government entities should use based on the timeframe of the investment. Nominal discount rates include inflation rates, whereas real discount rates reflect that the inflation effect has been removed. This model used real discount rates—separate calculations were used to account for inflation. This variable can be manipulated in the model to predict future costs more accurately as the OMB publishes updated rates annually. The discount rates can be found in Appendix D of this thesis. This input was used in both the lease and the purchase alternatives and to calculate the net present value of each investment alternative.

Discount Rate Factor (B): This is simply the factor applied to the net present value calculations. It is based on the current discount rate, as described above. This variable is used in both alternatives to determine net present value.

Incremental Cost per Vehicle (B): The incremental cost for each vehicle is the price difference between the AFV actually leased or purchased and the lowest-priced model, either gasoline or AFV (where available) for that particular make and class of vehicle. In every class of vehicle (light, medium, heavy) the GSA bases its price structure off of base models. Previously, Chapter II provided a more detailed explanation of incremental costs. This variable can be manipulated in the model to predict future costs more accurately, given more detailed and reliable data from the GSA. It applies to both model alternatives; however, the incremental costs for an AFV may be different, depending on whether the USMC leases or purchases the vehicle. Appendix F explains how these values were calculated and shows the associated spreadsheet tables.

Monthly Lease Rate per Vehicle (L): This represents the monthly lease rates charged by the GSA. It is used only in the lease version since lease rates do not apply to vehicles that are purchased outright. This variable can be manipulated in the model to reflect future lease rates more accurately, given more detailed and reliable data from the GSA. Appendix G explains how these values were calculated and shows the associated spreadsheet tables.

NPV of Total Annual Cost of Inventory, 2009 \$ (B): The NPV variable is used in both the lease and purchase alternatives. Discount rates are used to calculate NPV and

can be found in *OMB Circular No. A-94* (OMB, 1992) or Appendix D of this thesis. This value will serve as the ultimate comparison between leasing and purchasing and will be discussed in terms of “relative NPV.”

Purchase Price per Vehicle (P): This is the purchase price that the USMC pays the GSA Fleet for each vehicle. The GSA Fleet determines purchase prices based on what it pays for each vehicle, given existing contracts with car manufacturers and current market prices. The GSA Fleet does receive bulk-buy discounts and does not pay interest since it purchases vehicles in full, up front. This variable can be manipulated in the model to predict future prices more accurately, given more detailed and reliable data from the GSA. Appendix H explains how these values were calculated and shows the associated spreadsheet tables.

Raw Index (B): This variable accounts for the effect of inflation over time. The model relies on the inflation-calculator spreadsheet from the Naval Center for Cost Analysis (NCCA) website to compute the respective inflation rates and indices for both the lease and purchase models. Each version’s Raw Index was calculated using a different Appropriation Cost Category. The lease version used the Operations and Maintenance Marine Corps (O&M MC) Appropriation Cost category, while the purchase version used the Procurement Marine Corps (PMC) Appropriation Cost category. These particular inflation indices were used because the USMC uses O&M funds to pay for vehicle leases and procurement dollars when purchasing vehicles. Inflation affects these categories differently, so it was important to distinguish between the two for each model alternative. Appendix E displays the Raw Indices used, based on the NCCA inflation-rate index table.

Salvage Value per Vehicle (P): This value represents what the market is willing to pay for each vehicle, given its current condition and mileage at the time of sale. It is also the depreciation rate of a vehicle. For example, if the salvage value of a vehicle was 50%—meaning the seller received 50% of the vehicle’s original price at the time of resale—then it can be said that the vehicle depreciated 50%. Thus, salvage value and depreciation are one in the same—just viewed from opposing angles, based on context.

The model compiled historical data from the USMC and the GSA in an attempt to develop an acceptable cost-estimating relationship for predicting future salvage values of purchased AFVs. The variables analyzed were proceeds from vehicle sales (the actual dollar amount the GSA received for selling a particular vehicle), the model make and year, the calendar year it was sold, and the miles on each vehicle at the time of sale. We conducted several statistical regressions to see if one or a combination of multiple variables explained the given salvage value. Additionally, we conducted multi-collinearity tests between the variables to see if any correlation, or strong relationship, exists among them.

These statistical regressions and multi-collinearity tests revealed that the variables did not significantly explain, or predict, salvage value and that there was no relationship between them. Simply stated, the salvage value was random and unexplainable in the historical data we possessed. Given the unpredictability of salvage value based on stated variables, expert opinion and market conditions proved the necessary medium to develop a baseline for predicting the residual value of a vehicle. Based on this research, we used an average annual-depreciation rate of 25% for each vehicle. This variable can be changed given additional information, as well as more current and/or predicted future market conditions. Salvage value is only used in the purchase alternative as it applies to the value received when a vehicle is sold at the end of its useful life. When a leased vehicle is returned by the USMC to the GSA at the end of its lease period, the applicable salvage value is realized by the GSA vice the USMC.

Total Cost of Inventory, 2009 \$ (B): This is the summation of each Annual Cost of Inventory that was calculated for the six years under review (2004–2009).

Vehicles Acquired (B): As discussed in Chapter II, the USMC is mandated by law to acquire a certain percentage of AFVs by a specific deadline. The USMC used a phased approach in its AFV acquisition scheme to ramp up its fleet to the required amount prior to the deadline. These numbers reflect the acquisition of AFVs per year to

comply with the mandate. The definition of an AFV will be in accordance with our assumptions stated above and in Chapter II. This input applies to both the lease and purchase alternative.

Vehicles Returned (B): This input represents the number of vehicles either returned to the GSA Fleet at the end of a vehicle's lease agreement or sold at the end of its service life. For both the lease and the purchase alternatives, a service life of 3 years was used for compact sedans and 7 years for pickups and minivans because this is the standard service-life agreement the GSA Fleet maintains with the USMC.

Yearly Lease Rate per Vehicle (L): This is simply the monthly lease rate multiplied by 12 to represent annual expenses, which is the basis for estimating all future costs. It is used only in the lease alternative since lease rates do not apply to vehicles that are purchased outright.

Tables 4, 5, and 6 show the baseline NPV calculations for compact sedans, pickup trucks and minivans, respectively, based on the formulas, assumptions, inputs and variable discussed in the sections C, D, and E above.

Table 4. Compact Sedan Baseline Calculations

Lease (Wet) - Compact Sedan										
FY	Vehicles Acquired	Vehicles Returned	AFV Inventory	Inflation Adjusted Mthly Lease Rate per Vehicle	Inflation Adjusted Yearly Lease Rate per Vehicle	Inflation Adjusted Incremental Cost per Vehicle	Annual Cost of AFV Inventory	NPV of Total Annual Cost of AFV Inventory	5 Year Real Discount Rate	Discount Rate Factor
04	412	0	412	\$194	\$2,330	\$1,650	\$1,639,714	\$1,639,714	2.30%	1.000
05	71	0	483	\$216	\$2,592	\$903	\$1,208,227	\$1,181,063	2.30%	0.978
06	28	0	511	\$207	\$2,489	\$1,255	\$1,248,941	\$1,193,413	2.30%	0.956
07	8	7	512	\$202	\$2,426	\$1,318	\$1,243,751	\$1,161,733	2.30%	0.934
08	90	34	568	\$196	\$2,350	\$1,276	\$1,559,544	\$1,423,951	2.30%	0.913
09	243	63	748	\$233	\$2,796	\$0	\$2,124,106	\$1,895,824	2.30%	0.893
							Total Cost of Inv. (2009 \$) ==>	\$9,024,283	\$8,495,698	NPV of Total Cost of Inv. (2009 \$) <==

Purchase - Compact Sedan										
FY	Vehicles Acquired	Vehicles Returned	AFV Inventory	Inflation Adjusted Purchase Price per Vehicle	Inflation Adjusted Incremental Cost per Vehicle	Inflation Adjusted Total Avg Salvage Value (SV) per Year	Annual Cost of AFV Inventory	NPV of Total Annual Cost of AFV Inventory	5 Year Real Discount Rate	Discount Rate Factor
04	412	0	412	\$13,999	\$98	\$1,331,386	\$5,808,157	\$5,808,157	2.30%	1.000
05	71	0	483	\$12,043	\$0	\$223,301	\$855,047	\$835,823	2.30%	0.978
06	28	0	511	\$12,836	\$0	\$121,384	\$359,401	\$343,422	2.30%	0.956
07	8	7	512	\$15,982	\$3,198	\$67,282	\$153,443	\$143,324	2.30%	0.934
08	90	34	568	\$15,372	\$0	\$789,890	\$1,383,496	\$1,263,209	2.30%	0.913
09	243	63	748	\$15,400	\$0	\$2,806,650	\$3,742,200	\$3,340,018	2.30%	0.893
							Total Cost of Inv. (2009 \$) ==>	\$7,642,893	\$7,075,103	NPV of Total Cost of Inv. (2009 \$) <==

Table 5. Pickup Truck (4x2) Baseline Calculations

Lease (Wet) - Pickup 4X2										
FY	Vehicles Acquired	Vehicles Returned	AFV Inventory	Inflation Adjusted Mthly Lease Rate per Vehicle	Inflation Adjusted Yearly Lease Rate per Vehicle	Inflation Adjusted Incremental Cost per Vehicle	Annual Cost of AFV Inventory	NPV of Total Annual Cost of AFV Inventory	5 Year Real Discount Rate	Discount Rate Factor
04	21	0	21	\$228	\$2,733	\$3,652	\$134,069	\$134,069	2.30%	1.000
05	28	0	49	\$227	\$2,726	\$1,709	\$181,553	\$177,471	2.30%	0.978
06	42	0	91	\$220	\$2,643	\$1,610	\$312,344	\$298,457	2.30%	0.956
07	79	0	170	\$216	\$2,590	\$1,354	\$556,247	\$519,566	2.30%	0.934
08	49	0	219	\$207	\$2,484	\$1,918	\$665,022	\$607,203	2.30%	0.913
09	79	0	298	\$212	\$2,544	\$591	\$818,681	\$730,696	2.30%	0.893
							NPV of Total Cost of Inv. (2009 \$) ==>	\$2,667,916	NPV of Total Cost of Inv. (2009 \$) <==	

Purchase - Pickup 4X2										
FY	Vehicles Acquired	Vehicles Returned	AFV Inventory	Inflation Adjusted Purchase Price per Vehicle	Inflation Adjusted Incremental Cost per Vehicle	Inflation Adjusted Total Avg Salvage Value (SV) per Year	Annual Cost of AFV Inventory	NPV of Total Annual Cost of AFV Inventory	5 Year Real Discount Rate	Discount Rate Factor
04	21	0	21	\$11,883	\$433	\$52,080	\$258,652	\$258,652	2.30%	1.000
05	28	0	49	\$12,375	\$1,632	\$102,427	\$392,205	\$383,387	2.30%	0.978
06	42	0	91	\$11,849	\$258	\$171,749	\$508,527	\$485,917	2.30%	0.956
07	79	0	170	\$15,436	\$1,429	\$584,190	\$1,332,308	\$1,244,451	2.30%	0.934
08	49	0	219	\$15,612	\$2,069	\$494,623	\$866,334	\$791,012	2.30%	0.913
09	79	0	298	\$15,795	\$575	\$969,923	\$1,293,230	\$1,154,244	2.30%	0.893
							NPV of Total Cost of Inv. (2009 \$) ==>	\$2,579,167	NPV of Total Cost of Inv. (2009 \$) <==	

Table 6. Minivan Baseline Calculations

Lease (Wet) - Minivan										
FY	Vehicles Acquired	Vehicles Returned	AFV Inventory	Inflation Adjusted Mthly Lease Rate per Vehicle	Inflation Adjusted Yearly Lease Rate per Vehicle	Inflation Adjusted Incremental Cost per Vehicle	Annual Cost of AFV Inventory	NPV of Total Annual Cost of AFV Inventory	5 Year Real Discount Rate	Discount Rate Factor
04	19	0	19	\$222	\$2,663	\$2,335	\$94,967	\$94,967	2.30%	1.000
05	60	0	79	\$228	\$2,739	\$294	\$232,617	\$227,387	2.30%	0.978
06	34	0	113	\$225	\$2,695	\$32	\$307,687	\$294,007	2.30%	0.956
07	132	0	245	\$218	\$2,615	\$0	\$651,748	\$608,769	2.30%	0.934
08	99	0	344	\$210	\$2,520	\$0	\$901,239	\$822,882	2.30%	0.913
09	144	0	488	\$215	\$2,580	\$0	\$1,272,759	\$1,135,973	2.30%	0.893
						Total Cost of Inv. (2009 \$) ==>	\$3,461,017	\$3,183,985	NPV of Total Cost of Inv. (2009 \$) <==	

Purchase - Minivan										
FY	Vehicles Acquired	Vehicles Returned	AFV Inventory	Inflation Adjusted Purchase Price per Vehicle	Inflation Adjusted Incremental Cost per Vehicle	Inflation Adjusted Total Avg Salvage Value (SV) per Year	Annual Cost of AFV Inventory	NPV of Total Annual Cost of AFV Inventory	5 Year Real Discount Rate	Discount Rate Factor
04	19	0	19	\$19,099	\$3,003	\$84,554	\$419,931	\$419,931	2.30%	1.000
05	60	0	79	\$16,642	\$1,076	\$277,635	\$1,063,095	\$1,039,194	2.30%	0.978
06	34	0	113	\$15,640	\$274	\$182,745	\$541,083	\$517,026	2.30%	0.956
07	132	0	245	\$15,639	\$44	\$907,716	\$2,070,143	\$1,933,630	2.30%	0.934
08	99	0	344	\$16,213	\$0	\$916,381	\$1,605,047	\$1,465,498	2.30%	0.913
09	144	0	488	\$19,039	\$1,220	\$2,187,972	\$2,917,296	\$2,603,768	2.30%	0.893
						Total Cost of Inv. (2009 \$) ==>	\$4,640,786	\$4,003,238	NPV of Total Cost of Inv. (2009 \$) <==	

F. SENSITIVITY ANALYSIS

Sensitivity analysis, with respect to data, is a versatile method for analyzing the behavior of an activity, plan or process that involves uncertainty or is subject to change. If the USMC faces uncertain or variable market demand, fluctuating costs, or potential salvage (resale) values, then it can benefit from conducting sensitivity analyses. These analyses clarify the impact of uncertainty and change and can assist decision-makers in developing plans to mitigate or otherwise cope with risk.

Sensitivity analyses use data tables to show how a change in one or two variables will affect the independent variable—for this thesis, total cost. Discount rate, expected future-acquisition rate (total inventory), incremental cost, lease rate, purchase price, and salvage value are the variables subjected to change in the model in order to analyze their overall effect on total cost. We assigned these variables a range of discrete values that were applicable to realistic conditions and based on historical data. Like many other variables and inputs in this model, management can change these values pending information on future budget plans, acquisition strategies and market conditions relating to AFV resale values, incremental costs, and discount rates. Sensitivity analyses can also show breakeven points, or values at which there is indifference to either alternative. Five separate sensitivity analyses were conducted for each type of light-duty vehicle. The following is an explanation of each sensitivity analysis and its associated variables and ranges:

Sensitivity Analysis #1 – Salvage Value: Shows how the overall costs of leasing and purchasing differ with only a change in salvage value, holding all other inputs constant. The salvage value percentage is based on the purchase price. The ranges of values for each vehicle type differ to pinpoint the specific breakeven points between leasing and purchasing. The ranges are relatively small since the purpose was to identify the point at which purchasing becomes the more attractive alternative to leasing and vice versa.

Sensitivity Analysis #2—Salvage Value and Discount Rate: Shows how the overall costs of leasing and purchasing differ with changes in both salvage value and the real discount rates, holding all other inputs constant. The salvage-value range for this analysis was expanded to reflect the range of potential values that are realistic in the market place; it is rare that a vehicle can be sold for more than 70% its purchase value. The discount-rate range is between 0% and 7%. This range was used based on historical annual data published by the OMB in its Table of Past Years Discount Rates from Appendix C of *OMB Circular No. A-94* (OMB, 2008b).

Sensitivity Analysis #3—Incremental Costs: Shows how the overall costs of leasing and purchasing differ with changes in incremental costs, holding all other inputs constant. The incremental costs increase by \$250, starting from \$0 through \$6,000; this adjustment and range were selected for two reasons: 1) increments less than \$250 provide small changes in the costs and, therefore, add little value, and 2) based on historical data, the USMC has never leased a vehicle with an incremental cost of more than \$6,000.

Sensitivity Analysis #4—Lease Rates and Purchase Costs: Shows how the overall costs of leasing and purchasing differ with changes in the lease rates and purchase prices, holding all other inputs constant. The range for these variables is based on percentages of how much the future lease rate or purchase price for an AFV can potentially change based on future market conditions and the GSA's price levels.

Sensitivity Analysis #5—Fleet Inventory: Shows how the overall costs of leasing and purchasing differ with changes in total fleet inventory, holding all other inputs constant. The range for these variables is based on percentages of how much the USMC's AFV fleet might either increase or decrease, depending on future acquisition goals and budgetary constraints.

The USMC currently leases nearly all of its light-duty vehicles. The first portion of the model shows the total cost for the USMC per vehicle type from 2004 through 2009, with leasing as the contractual approach. The second portion of the model

compares that total lease cost to what the total cost for the USMC would have been if the alternative approach of purchasing had been used. These values, or costs, are represented as NPVs, or real, current-year dollar values. For these two analyses, the alternative with the higher NPV is the preferred alternative. The relative NPV is calculated by subtracting the lease option NPV from the purchase option NPV. These NPVs form the baseline from which all five sensitivity analyses are conducted.

Finally, the third portion of the model adjusts those variables within realistic ranges for each of the five sensitivity analyses and then compares the two alternatives and their associated NPVs. For the purposes of this model and for each of the five sensitivity analyses, a positive relative NPV indicates that purchasing is the preferred alternative, and a negative relative NPV indicates that leasing is the preferred alternative. These analyses are useful as a means of predicting future costs, given anticipated changes in inventory, discount rates, lease rates, purchase prices, salvage values, and incremental costs. Appendix I shows the data tables created for each variable, their associated effect on total cost, and their breakeven points between leasing and purchasing. The results and interpretations of these sensitivity analyses will be discussed further in Chapter V: Model Results.

G. SUMMARY

The model can be used to analyze the financial implications of various alternatives associated with lease and purchase options. Sensitivity analysis can be performed on a number of variables, such as future acquisition goals, incremental costs, discount rate, and potential salvage value. Given numerous assumptions and multiple input variables, a model was developed to examine how each of these affect the overall cost of leasing versus purchasing vehicles for a given year, or as projected out over numerous years based on future acquisition strategies and budget allocations. The next chapter will examine the results of this model and its various inputs and make recommendations regarding leasing versus purchasing as well as for further study and research.

V. MODEL RESULTS

A. OVERVIEW

The model examined five sensitivity analyses in order to compare the lease versus purchase alternatives for the USMC. The five sensitivity analyses focused on salvage values, discount rates, incremental costs, lease rates and purchase prices, and fleet inventory for each vehicle type (compact sedans, pickup trucks, and minivans). These factors provided significant and relevant analysis for comparing the two alternatives. Each analysis showed relative cost—or relative NPV—for both alternatives, how those costs changed given changes in the variable(s), and the comparison between both options. The NPV comparison between the two alternatives is the bottom-line result. For purposes of this thesis and the associated model, a positive relative NPV indicates that purchasing was the preferred alternative; a negative relative NPV indicates that leasing was the preferred alternative.

It is important to mention the starting point for both the lease and purchase alternatives prior to discussing the results of each sensitivity analysis. Table 7 shows the initial analysis results for both leasing and purchasing for each vehicle type.

Table 7. Initial findings of Benefit-Cost Analysis

NPV of leasing versus purchasing (positive NPV indicates purchase is the preferred alternative)			
	Compact Sedans	Pickup Trucks	Minivans
Lease	\$8,495,698	\$2,467,461	\$3,183,985
Purchase	\$7,075,103	\$2,245,574	\$4,003,238
Relative NPV	\$1,420,595	\$221,887	-\$819,253

Given the historical data from 2004 through 2009 and the actual inventories, lease rates, purchase prices, salvage values, incremental costs and discount rates, the USMC would have been better off purchasing its compact sedans and pickup trucks vice leasing them and was better off leasing minivans. With these values as the starting point for the preferred alternatives, the next section of this chapter will discuss in detail the results of

the five sensitivity analyses for all three vehicle types and how the net present values fluctuated for each one. Only those tables and spreadsheets that portrayed the most convincing arguments and proved to be the most relevant are displayed within the chapter. All other spreadsheet analyses can be found in Appendix I.

B. COSTS OF LEASING VERSUS PURCHASING

The initial NPVs found for each vehicle type drove the results of the following analyses. For example, the compact sedans' net value was roughly \$1.5 million dollars in favor of purchasing. Given this high relative NPV, it was clear why the breakeven points for some of the variables were extremely high—to shift the preferred alternative to leasing. The same observation held true for pickup trucks and minivans—the higher, or lower, the initial relative NPV, the more, or less, drastically variables changed to shift between leasing and purchasing as the preferred alternative.

1. Sensitivity Analysis #1: Salvage Value/Depreciation

The question posed in this analysis was: Given changes in salvage value/depreciation, what are the corresponding changes in relative NPV between lease and purchase?

This analysis examines how a vehicle's salvage value, or the rate at which it depreciates, affects the overall cost. Purchasing a vehicle is usually more expensive than leasing one; however, if the USMC can purchase a vehicle and sell it at the end of its useful life for a reasonable price, then it can recoup some of the overall costs and use that money for future investments. Compared to all of the variables tested in this model, salvage value proved to be one of the most important driving factors in determining the preferred alternative. Without sufficient salvage values, leasing would always be the preferred alternative.

The breakeven point, in terms of depreciation per year, in which the USMC would be indifferent to leasing or purchasing is 36% for compact sedans, 28% for pickup trucks (4x2), and 18% for minivans. These percentages reflect average depreciation per year, and they directly correlate to the desired salvage value. Based on historical data,

expert opinion, and vehicle market research, a vehicle usually depreciates as much as 20–25% after the first year and roughly 18–20% every year thereafter. Given these rates, the salvage value for a vehicle after the first year is roughly 75–80% of the purchase price and then decreases by 18–20% each subsequent year. The results of this analysis showed different depreciation rates for each vehicle type and, thus, different salvage values. Compact sedans stand the best overall chance of meeting market demand for resale as compared to pickup trucks and minivans, given each breakeven point. However, given historical depreciation rates, it is difficult to judge the best alternative solely based on depreciation, or salvage value, since these rates may fluctuate over time with improved technology and engineering and changing market demand.

Table 8 shows these results for compact sedans in condensed form. The full results for compact sedans, pickup trucks and minivans can be found in Appendix I.

Table 8. Compact Sedans – Salvage Value

Change in NPV	Depreciation Factor as a Percentage of Purchase Price						
	34%	35%	36%	37%	38%	39%	40%
Lease	\$8,495,698	\$8,495,698	\$8,495,698	\$8,495,698	\$8,495,698	\$8,495,698	\$8,495,698
Purchase	\$7,075,103	\$8,257,311	\$8,364,768	\$8,468,249	\$8,567,950	\$8,664,057	\$8,756,749
Net Purchase	\$1,420,594	\$238,387	\$130,930	\$27,448	-\$72,253	-\$168,359	-\$261,051
							-\$350,499

2. Sensitivity Analysis #2: Salvage Value versus Discount Rate

The question posed in this analysis was: Given changes in salvage value/depreciation and the discount rate, what are the corresponding changes in relative NPV between lease and purchase?

This analysis examines not only salvage value but also how changes in the discount rate affect the overall NPV of leasing versus purchasing. In general, as the discount rate increases, the vehicle's salvage value has less of an impact on the overall net present value of the investment—the vehicle effectively depreciates faster. The analysis highlighted this characteristic for all three vehicle types.

The breakeven points, in terms of depreciation, in which the USMC is indifferent to leasing and purchasing changed for all three vehicle types as the discount rate changed.

As the discount increased from 0% to 7%, the depreciation rate decreased from 40% to 27% for compact sedans, from 31% to 25% for pickup trucks, and from 20% to 15% for minivans. These observations show that the depreciation rate is more elastic with respect to changes in the discount rate for compact sedans and more inelastic for pickup trucks and minivans. When the purchase option is the clear preference (as with compact sedans), which supports high depreciation rates, there is a large impact on the relative NPV as the discount rate increases. Conversely, when the purchase option is not the clear preference (as with minivans), there is a small impact on the relative NPV as the discount rate increases. Essentially, pickup trucks and minivans appear to hold their value better than compact sedans when the discount rate increases.

Table 9 shows these results for compact sedans in condensed form. The full results for compact sedans, pickup trucks and minivans can be found in Appendix I.

Table 9. Compact Sedans – Salvage Value and Real Discount Rate

Real Discount Rate	Net Purchase	Depreciation Factor as a Percentage of Purchase Price							
		27%	29%	31%	33%	35%	37%	39%	41%
	\$1,420,594								
	0%	\$1,717,841	\$1,400,028	\$1,106,605	\$835,359	\$584,241	\$351,357	\$134,960	-\$66,558
	1.0%	\$1,446,913	\$1,147,519	\$871,101	\$615,576	\$379,011	\$159,623	-\$44,233	-\$234,071
	2.0%	\$1,193,001	\$910,791	\$650,240	\$409,382	\$186,396	-\$20,398	-\$212,553	-\$391,495
	3.0%	\$954,835	\$688,671	\$442,934	\$215,770	\$5,463	-\$189,575	-\$370,804	-\$539,572
	4.0%	\$731,254	\$480,081	\$248,185	\$33,816	-\$164,646	-\$348,698	-\$519,720	-\$678,983
	5.0%	\$521,195	\$284,037	\$65,081	-\$137,327	-\$324,715	-\$498,497	-\$659,976	-\$810,351
	6.0%	\$323,680	\$99,634	-\$107,217	-\$298,435	-\$475,463	-\$639,637	-\$792,189	-\$934,251
	7.0%	\$137,815	-\$73,958	-\$269,478	-\$450,220	-\$617,551	-\$772,731	-\$916,926	-\$1,051,205

3. Sensitivity Analysis #3: Changes in Incremental Costs for both Leased and Purchased Vehicles

The question posed in this analysis was: Given changes in incremental costs for both leased and purchased vehicles (both have differing values), what are the corresponding changes in relative NPV between lease and purchase?

This analysis examines how changes in the incremental costs for both leased and purchased vehicles affect the overall NPV of leasing versus purchasing. The incremental costs associated with leased and purchased vehicles can vary as a whole and are usually

independent of each other; they are not necessarily the same for a given vehicle. The USMC has leased various types of vehicles, and not all of them have had the same incremental costs. Historical data has shown that these costs have ranged from \$0 to as much as \$5,000 per vehicle. This cost can play a significant role in 1) the decision to acquire the vehicle and 2) the cost and subsequent NPV of the vehicle as an overall investment.

Much like salvage value, incremental costs played an important role in the overall net present values for both leasing and purchasing. The number and type of vehicles acquired (compact sedan, pickup truck, or minivan) each year and their associated incremental costs weighed heavily in determining the preferred alternative. The USMC leased vehicles during certain years that had zero incremental costs. However, had it purchased those same vehicles, the incremental costs would have been as high as \$3,200 (\$3,600 adjusted for inflation). Thus, incremental costs generated significant parity between the net present values for leasing and purchasing. The analyses supported this as the preferred alternative, and breakeven points between the two (lease and purchase) were different for all three vehicle types.

The analysis performed to address this question also showed that purchasing compact sedans was always the preferred alternative. This was true when 1) the incremental cost of leasing and purchasing were equal, whether \$0 or \$2,500, and 2) the incremental cost to lease was \$0, and the incremental cost to purchase was as much as \$1,000. Pickup trucks told a slightly different story. Leasing was the preferred alternative only when the incremental cost of leasing and purchasing were both \$0. However, once the incremental cost to lease increased to \$250, and the incremental cost to purchase remained at \$0, purchasing became the preferred alternative. Conversely, leasing was almost always the preferred alternative for minivans. When the incremental cost of leasing and purchasing remained the same, leasing was the preferred alternative. Purchasing did not become the preferred alternative until the incremental cost to lease increased to \$1,750, holding the incremental cost to purchase the same.

As previously stated, each vehicle type showed different increases in the incremental cost of leasing for which purchasing would become, or remain, the preferred alternative. A final observation in this analysis deals with marginal, incremental cost rates of change and how they affected the breakeven points between leasing and purchasing. As the incremental cost to leasing increased by \$250, the marginal change in the incremental cost to purchase rose by \$500 and purchasing still remained the preferred alternative. This observation held true for all three vehicle types and showed that once the breakeven point was reached, the incremental costs of purchasing could rise faster than the incremental cost of leasing, and purchasing would remain the preferred alternative.

Table 10 shows these results for compact sedans in condensed form. The full results for compact sedans, pickup trucks and minivans can be found in Appendix I.

Table 10. Compact Sedans – Incremental Costs (Lease and Purchase)

Incremental Cost -- Purchase	Net Purchase	Incremental Cost -- Lease								
		\$1,420,594	\$0	\$250	\$500	\$750	\$1,000	\$1,250	\$1,500	\$2,000
\$1,000	\$75,594	\$279,266	\$482,939	\$686,612	\$890,284	\$1,093,957	\$1,297,630	\$1,501,302	\$1,704,975	
\$1,250	-\$49,648	\$154,024	\$357,697	\$561,370	\$765,042	\$968,715	\$1,172,387	\$1,376,060	\$1,579,733	
\$1,500	-\$174,891	\$28,782	\$232,455	\$436,127	\$639,800	\$843,473	\$1,047,145	\$1,250,818	\$1,454,491	
\$1,750	-\$300,133	-\$96,460	\$107,213	\$310,885	\$514,558	\$718,230	\$921,903	\$1,125,576	\$1,329,248	
\$2,000	-\$425,375	-\$221,702	-\$18,030	\$185,643	\$389,316	\$592,988	\$796,661	\$1,000,334	\$1,204,006	
\$2,250	-\$550,617	-\$346,945	-\$143,272	\$60,401	\$264,073	\$467,746	\$671,419	\$875,091	\$1,078,764	
\$2,500	-\$675,859	-\$472,187	-\$268,514	-\$64,841	\$138,831	\$342,504	\$546,177	\$749,849	\$953,522	
\$2,750	-\$801,102	-\$597,429	-\$393,756	-\$190,084	\$13,589	\$217,262	\$420,934	\$624,607	\$828,280	
\$3,000	-\$926,344	-\$722,671	-\$518,998	-\$315,326	-\$111,653	\$92,020	\$295,692	\$499,365	\$703,038	
\$3,250	-\$1,051,586	-\$847,913	-\$644,241	-\$440,568	-\$236,895	-\$33,223	\$170,450	\$374,123	\$577,795	
\$3,500	-\$1,176,828	-\$973,155	-\$769,483	-\$565,810	-\$362,137	-\$158,465	\$45,208	\$248,881	\$452,553	
\$3,750	-\$1,302,070	-\$1,098,398	-\$894,725	-\$691,052	-\$487,380	-\$283,707	-\$80,034	\$123,638	\$327,311	
\$4,000	-\$1,427,312	-\$1,223,640	-\$1,019,967	-\$816,294	-\$612,622	-\$408,949	-\$205,277	-\$1,604	\$202,069	

4. Sensitivity Analysis #4: Changes in Monthly Lease Rates versus Changes in Purchase Prices

The question posed in this analysis was: Given changes in monthly lease rates and purchase prices, what are the corresponding changes in the relative NPV between lease and purchase?

This analysis examines the effect on net present value for each alternative as the monthly lease rate and purchase price change for each vehicle. Car manufactures continually adjust their purchase prices and lease rates as the market demand changes and as technology improves and vehicles become more fuel efficient. Therefore, it was important to factor in these potential decreases or increases in lease rates and purchase prices and how they might affect the relative NPV of leasing and purchasing. Given that costs tend to rise every year, the analysis focused on the results in terms of how increases in both lease rate and purchase price affected the relative NPVs.

The results of the analyses showed commonality between the compact sedans and the pickup trucks: purchasing was the preferred alternative for both. Holding lease rates constant, purchase prices could increase by as much as 25% for compact sedans and 15% for pickup trucks before leasing became the preferred alternative. The opposite held true for minivans. Purchase prices would have to decrease by as much as 30% before purchasing became the preferred alternative.

Table 11 shows these results for compact sedans in condensed form. The full results for compact sedans, pickup trucks and minivans can be found in Appendix I.

Table 11. Compact Sedans – Lease Rate versus Purchase Price

Purchase Price	Net Purchase	Monthly Lease Rate					
		-30%	-20%	-10%	0%	10%	20%
-10%	\$1,420,594	-\$158,085	\$602,427	\$1,362,938	\$2,123,450	\$2,883,961	\$3,644,473
-5%		-\$509,512	\$250,999	\$1,011,511	\$1,772,022	\$2,532,533	\$3,293,045
0%		-\$860,940	-\$100,428	\$660,083	\$1,420,594	\$2,181,106	\$2,941,617
5%		-\$1,212,368	-\$451,856	\$308,655	\$1,069,167	\$1,829,678	\$2,590,190
10%		-\$1,563,795	-\$803,284	-\$42,772	\$717,739	\$1,478,251	\$2,238,762
15%		-\$1,915,223	-\$1,154,711	-\$394,200	\$366,312	\$1,126,823	\$1,887,335
20%		-\$2,266,650	-\$1,506,139	-\$745,627	\$14,884	\$775,395	\$1,535,907

	25%	-\$2,618,078	-\$1,857,566	-\$1,097,055	-\$336,544	\$423,968	\$1,184,479
	30%	-\$2,969,506	-\$2,208,994	-\$1,448,483	-\$687,971	\$72,540	\$833,052
	35%	-\$3,320,933	-\$2,560,422	-\$1,799,910	-\$1,039,399	-\$278,887	\$481,624
	40%	-\$3,672,361	-\$2,911,849	-\$2,151,338	-\$1,390,826	-\$630,315	\$130,197

5. Sensitivity Analysis #5: Changes in Overall Fleet Inventory (Per Vehicle Type)

The question posed in this analysis was: Holding all variables constant, if the Marine Corps wants to either increase or decrease its inventory of AFVs (based on current fleet size), what is the corresponding increase or decrease in fleet size that will shift the preferred alternative between leasing and purchasing?

This final analysis examines how the change in fleet inventory would affect the relative NPVs. The USMC's acquisition goals change each year based on budgetary limitations and the needs of the gaining units and commands. Additionally, all of the inputs and variables described thus far may constrain how many non-tactical vehicles the USMC actually acquires each year. Given these limitations and constraints, the total fleet size will affect the overall net present value of this investment. For these reasons, it was important to show how potential changes in the Marine Corps fleet may affect the NPV of AFV acquisitions for both leasing and purchasing.

The results of this analysis, much like in Analysis #4, showed commonality between the compact sedans and the pickup trucks: purchasing was the preferred alternative for both, whether inventory increased or decreased. The opposite held true for minivans: leasing was always the preferred alternative, no matter the change in inventory.

Table 12 shows these results for compact sedans in condensed form. The full results for compact sedans, pickup trucks and minivans can be found in Appendix I.

Table 12. Compact Sedans – Changes in AFV Fleet Inventory

Change in NPV		Change in Inventory					
		-69%	-8%	-4%	0%	4%	8%
Lease	\$8,495,698	\$2,633,666	\$7,816,042	\$8,155,870	\$8,495,698	\$8,835,526	\$9,175,354
Purchase	\$7,075,103	\$2,095,817	\$6,497,795	\$6,786,449	\$7,075,103	\$7,363,758	\$7,652,412
Net Purchase	\$1,420,594	\$537,849	\$1,318,247	\$1,369,421	\$1,420,594	\$1,471,768	\$1,522,942

6. Aggregate

The USMC does not acquire just one type of vehicle each fiscal year. It acquires a variety of different vehicles, given the needs of its supported units and commands. The analyses in this model analyzed each vehicle type separately in order to compare like products and get accurate results. Additionally, it is important that the USMC consider the results for each vehicle type as a whole, not just individually, during the decision-making process to quantify the overall net present value of its investment. While it was difficult to conduct analyses on 100% of the USMC's fleet given the historical data maintained and collected, this model analyzed roughly 60% of the fleet and, thus, attempted to create an accurate and representative picture of the USMC's total AFV fleet cost. Table 13 shows the total net present value for leasing and purchasing for all three vehicle types.

Table 13. Aggregate Net Present Value

Lease (Wet)			
	AFV Inventory	Yearly Cost of AFV Inventory	NPV of Total Yearly Cost of AFV Inventory
Compact Sedans	3,234	\$9,024,283	\$8,495,698
Pickup 4X2s	848	\$2,667,916	\$2,467,461
Minivans	<u>1,288</u>	<u>\$3,461,017</u>	<u>\$3,183,985</u>
Total	5,370	\$15,153,216	\$14,147,144

Purchase			
	AFV Inventory	Yearly Cost of AFV Inventory	NPV of Total Yearly Cost of AFV Inventory
Compact Sedans	3,234	\$7,642,893	\$7,075,103
Pickup 4X2s	848	\$2,579,167	\$2,245,574
Minivans	<u>1,288</u>	<u>\$4,640,786</u>	<u>\$4,003,238</u>
Total	5,370	\$14,862,846	\$13,323,916

Potential Savings =	\$823,229
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The USMC could have saved roughly \$823,000, if it had chosen to purchase vice lease its entire vehicle fleet. However, if the USMC made the lease or purchase decision

based on vehicle type, it could have saved roughly \$1.7 million, if it had purchased compact sedans and pickup trucks and continued to lease minivans. It appears that the “one size fits all” policy is not the optimal solution for the USMC. The USMC chose, based on the 1993 *COBRA* study recommendations, to lease the preponderance of its vehicle fleet. However, the USMC could experience significant cost savings if it adopts a more selective acquisition strategy: leasing or purchasing vehicles based on vehicle type, potential salvage value, and current incremental costs and discount rates.

C. SUMMARY

The model examined the USMC’s AFV inventory from 2004 through 2009 to develop an overall picture of its acquisition strategy and determine how this affected its overall cost to acquire these vehicles. The five sensitivity analyses compared the lease versus purchase alternatives for the USMC by changing salvage values, discount rates, incremental costs, lease rates, purchase prices, and fleet inventory for each vehicle type (compact sedans, pickup trucks, and minivans). Each analysis showed overall cost—or net present value—for both alternatives, how those costs changed given changes in the variable(s), and the relative NPV between both. These factors provided significant and relevant analysis for comparing the two alternatives.

Given the historical data and the changes in the variables that were examined in this model, the USMC would have been better off purchasing its compact sedans and pickup trucks vice leasing them and was better off leasing minivans. Salvage value and incremental costs greatly impacted the preferred alternative and the associated breakeven points. However, these were directly related to the number and type of vehicles required since they ultimately affected salvage value and incremental costs. While the results held true for each vehicle type based on the model input data, they were also based on limited information and can vary given different starting values and inputs.

VI. CONCLUSIONS

A. INTRODUCTION

Numerous legislative acts and executive orders mandate the USMC to acquire and maintain a specified number of AFVs in order to comply with governmental regulations and environmental acts. Understandably, there are hefty costs associated with these mandates. Currently, the USMC leases all AFVs through the GSA Fleet and will, for the foreseeable future, continue to do so. However, given there are certain incremental costs associated with both leasing and purchasing, and there are salvage values associated with purchased vehicles, it may prove cheaper to purchase AFVs, maintain and use them for more than three years, and then sell them at the end of their useful lives. By doing so, the USMC can potentially maintain the efficacy of its AFV fleet and keep costs at a minimum, without sacrificing mission accomplishment.

This thesis provides a detailed analysis of the costs of both leasing and purchasing the USMC's fleet of AFVs. It examined what, if any, benefits there were for the USMC to lease and purchase its current AFV fleet. More specifically, it analyzed what the USMC's optimal acquisition decision should have been (lease or purchase), given changes over time in purchasing patterns, anticipated salvage values, and incremental costs.

This thesis attempted to identify the costs of both leasing and purchasing and their subsequent relative NPVs, given changes in the variables mentioned above and the rate at which those variables change. It is hoped that the model developed for this analysis and its associated results will contribute to greater awareness and decision-making power for the USMC Commercial Vehicle Fleet Center leadership regarding the future acquisition of AFVs.

B. CONCLUSIONS AND RECOMMENDATIONS

The conclusions of this thesis reflect the result of the available information at the time of collection, the accuracy of that information, and specific assumptions made to

analyze the data and get valued results. The assumptions regarding the variables and inputs used in the model, as described in Chapter IV, are subject to change and interpretation, given additional information and more accurate data-collection processes and record-keeping.

1. Lease versus Purchase: “One Size Fits All” Policy

The primary conclusion of this thesis is that the USMC would have been better off purchasing vice leasing its AFV fleet. This conclusion was based on comparing the USMC’s actual AFV acquisition strategy and the significant costs associated with those vehicles. Given the choice to either lease or purchase its entire AFV fleet, the USMC could have saved roughly \$823,000, if it had chosen to purchase vice lease those vehicles.

2. “Hybrid” Policy

The USMC chose, based on the 1993 *COBRA* study recommendations, to lease the preponderance of its vehicle fleet, implementing a “one size fits all” policy. However, the USMC could have experienced significantly larger cost savings if it had adopted a more selective, or hybrid, acquisition strategy: leasing or purchasing vehicles based on vehicle type, potential salvage value, wear and tear (mileage and maintenance), and current incremental costs and discount rates. These overall savings could have increased from roughly \$823,000, as described above, to roughly \$1.7 million, if it had purchased compact sedans and pickup trucks and continued to lease minivans. It appears that the “one size fits all” policy is not necessarily the optimal solution for the USMC.

As mentioned above, one factor to consider in the lease-versus-purchase decision is vehicle wear and tear. Based on historical data, vehicle use is not evenly distributed across the USMC’s fleet. Unit-specific requirements dictate and drive the amount of dependence and, thus, wear and tear placed on AFVs for mission accomplishment. As a result, the USMC has returned some vehicles to the GSA Fleet after as little as two years with over 146,000 miles driven, in the most extreme case. The thought process, in general, behind purchasing vehicles is that the USMC can extend their useful life and

spread their total costs over a longer period. However, the USMC puts so many miles on some of its vehicles that it ends up turning them in after three years, or sooner—thus negating the advantage of keeping them beyond three years.

Additionally, vehicle selection based on incremental costs plays a huge role in the overall cost for the USMC and the decision to lease or purchase. For example, the USMC leased compact sedans with relatively moderate incremental costs. If it would have purchased the same type and number of vehicles, it would have paid much less—almost nothing—in incremental costs and overall total costs. The USMC’s decision to lease minivans, on the other hand, was a more cost-effective acquisition strategy than purchasing them. It leased minivans with low, or almost no incremental costs—in turn minimizing overall total costs. If it would have purchased the same type and quantity of vehicles, then it would have paid considerably more in total costs.

3. Inputs and Variables

Based on what has been presented and the results of the model, the decision to lease or purchase vehicles is situationally dependent. The USMC cannot control discount rates, salvage values, inflation rates, lease rates, purchase prices or incremental costs. However, it can control how many and what types of vehicles it purchases. These factors—both uncontrollable (those dictated by market conditions) and controllable—taken as a whole ultimately affect the lease-versus-purchase decision.

Before the USMC decides to lease or purchase vehicles, it must first examine a few independent factors associated with the analysis. The decision, as per the scope of work completed in this thesis, should be based on the anticipated salvage values given current market conditions, vehicle usage or mission, and the incremental costs published annually by the GSA. These factors, considered in whole, will determine the acquisition strategy. The USMC should consider:

a. Available Vehicles. The GSA defines specific categories and subcategories for each vehicle type and publishes these annually. The USMC should compare all of these vehicles to determine which one will provide the best value in terms of:

1. Vehicle Incremental Costs. These should be reviewed in terms of both leasing and purchasing, as they can be different depending on which alternative the USMC chooses.

2. Vehicle Purchase Price or Lease Rate.

3. Vehicle Salvage Value. Every year the GSA sells, usually back to the dealerships, its used AFVs at government auction. Examining these auctions can provide the USMC with real data on how well different vehicle types retained their value based on age and condition.

4. Historical Operating and Maintenance Costs. These costs include mileage and gas prices, vehicle technology, available parts and their associated costs, and repair costs, to name a few. The USMC can get these costs from the GSA and use them in the decision-making process.

b. Anticipated mission of each vehicle. The USMC should consider the anticipated use and mission of each vehicle, depending on which unit it is allocated to. For example, recruiting commands, based on their mission, have historically put more mileage on their vehicles than commands that operate locally on their station or base. These circumstances can drive the acquisition strategy for a specific vehicle based on its intended use and gaining command.

4. Data Collection

The conclusions in this thesis were the result of our modifications to the existing data in an effort to analyze the USMCs past decisions. It is very important for both the USMC and the GSA to maintain accurate information pertaining to the acquisition, operations, and maintenance costs of both gas-burning vehicles and AFVs. Historical data sets filled with rich and accurate information will contribute to more detailed and

higher-value research on any and all topics related to commercial vehicles. More accurate and abundant data sets will help both the USMC and the GSA analyze their internal decision-making processes and the effects of their decisions based on past acquisition policies, incremental costs, and salvage values. It will also provide the USMC more capability to accurately predict future costs and optimal acquisition solutions in an effort to minimize costs—especially given the current economic climate and potential for budget reductions.

C. SUMMARY

Based on the analyses conducted in this thesis, the USMC should consider adopting a more hybrid approach of both leasing and/or purchasing its AFV fleet. It should compare vehicle purchase prices or lease rates, incremental costs, salvage values, and the vehicles' intended use and gaining command to determine whether to lease or purchase. Taking these factors into consideration, the USMC can potentially reduce its overall AFV fleet acquisition costs and subsequently increase the AFV fleet inventory, given consistent budgetary spending—in other words, it can get more bang-for-its-buck.

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APPENDIX A: TYPES/DEFINITIONS OF ALTERNATIVE-FUELS

Methanol - Produced from natural gas using proven technology, methanol is a convenient liquid fuel. As a blend of 85% methanol and 15% gasoline (M85), methanol is a fuel for which vehicle manufacturers can easily design either a dedicated or Flexible-Fuel Vehicle (FFV) that will out-perform an equivalent gasoline vehicle. Disadvantages of methanol include low energy density (meaning there is less energy available per gallon when compared to gasoline) and unfavorable cold start characteristics. The range of methanol fueled vehicles is approximately 50% less for the same size fuel tank because of the lower energy density. Fueling procedures are very similar to gasoline. Note: This fuel is corrosive and should only be used in vehicles designed or modified to use it.

Ethanol (ethyl alcohol) - Like methanol, ethanol is a liquid fuel that can be quite readily used, with few problems, in vehicles. Disadvantages of ethanol are the same as methanol, and it should only be used in vehicles designed or modified for ethanol use. A gallon of ethanol contains only about two-thirds the energy of one gallon of gasoline; therefore, range is about 33% less than gasoline powered vehicles with the same size fuel cell. However, performance is just about the same as with gasoline. Fueling is also similar to gasoline.

Natural Gas - The physical makeup of natural gas tends to make it a low emission fuel. Natural gas contains virtually no nitrogen or sulfur and does not mix with oil. It will not foul engine combustion chambers, engine oils, or spark plugs as readily as gasoline. Natural gas may help reduce the deterioration of emissions control devices common to gasoline-powered automobiles. Furthermore, the use of natural gas would prove strongly beneficial in combating ozone pollution.

Compressed Natural Gas (CNG) has been condensed under high pressures in a container, typically between 2000 and 3600 pounds per square inch (psi). The gas expands when released for use as a fuel. Performance of a CNG powered vehicle is approximately the same as gasoline powered vehicles; however, range is less than 50% that of gasoline powered vehicles. Fueling can be accomplished by either fast (approximately 5 minutes) or slow (usually overnight) methods. Fast methods require additional infrastructure to support refueling.

Liquefied Natural Gas (LNG) can also be a fuel source. LNG is natural gas which has been cooled to approximately minus 260 degrees where it can be stored in its liquid state at atmospheric pressure. It can then be transferred to insulated fuel tanks on vehicles and used in the same manner as CNG. The advantages of LNG is the fuel tanks are considerably lighter than similar capacity CNG tanks. LNG can also be used as feed stock for production of CNG. LNG fuel handling and transfer requires special cryogenic equipment to maintain the fuel in the liquid state and minimize boil off and resulting fuel loss during storage and transfer.

Liquefied Petroleum Gas (LPG) - This is the most common alternative fuel in the United States. It is a gas at ambient (normal) temperatures and pressures. Under storage pressures, about 100 to 300 psi, it is a liquid. LPG is composed primarily of propane, with lesser amounts of butane and other hydrocarbons. It is a by-product of natural gas processing and petroleum refining. Performance of LPG fueled vehicles is about 25% less than gasoline powered vehicles. Fueling is accomplished with a leak-tight pressurized connection between the fuel nozzle and the vehicle. Otherwise it is similar to pumping gasoline.

Electricity - Electric vehicles are an exciting concept because they emit virtually no air pollutants. However, the goal of pollution reduction is accomplished only if the power charging the batteries is not derived from a coal-fired power plant. Unlike combustion engines, electric motors do not continue running when the vehicle is stopped, thereby conserving energy in stop-and-go traffic. Disadvantages include high cost and short traveling range, usually about 50 miles per charge. Recharging is dependent upon the power requirements of the batteries. Some vehicles require 120, 240, or 440 volt AC power sources, and usually take from 4 to 8 hours to fully recharge. Quick charge systems are under development.

Hybrid Electric Vehicles (HEV) are also available. HEVs combine electric drive trains with conventional (gas or diesel) or alternative fuel drive trains to achieve higher energy efficiency when compared to conventional vehicles.

Hydrogen - Hydrogen fueled vehicles emit virtually no hydrocarbons, particulates, carbon dioxide, or carbon monoxide. The only significant air pollutant emitted by a hydrogen-fueled vehicle is nitrogen oxide. Because hydrogen vehicles emit no carbon dioxide, they are viewed as an especially attractive option for reducing global warming trends. These vehicles are still in the research stage and are not generally available. A disadvantage of hydrogen-fueled vehicles is flammability.

APPENDIX B: ENVIRONMENTAL PROTECTION AGENCY ACTS

1. Clean Air Act Amendments of 1990 (*Public Law 101-549*); specifically Section 241, *Definitions*, Section 242, *Requirements Applicable To Clean Fuel Vehicles*, and Section 246, *Centrally Fueled Fleets*:

- **DEFINITIONS** – Language created to define terms similar to: alternative fuel, alternative fuel vehicle, light duty motor vehicle, and fleet. (**Note:** Over the course of several new pieces of legislation, definitions of the terms above have been either amended or redefined.)
- **VEHICLE SIZE** – Vehicle classes established by Gross Vehicle Weight Rating (GVWR).
- **COVERED AREAS** – Federal fleets (possessing 10 or more vehicles and capable of being centrally fueled) operating in a metropolis area with a population of 250,000 people or more. (**Note:** Once created, federal fleets would also be required to meet the requirements of State Implementation Plans (SIP) if state laws were more stringent than federal laws.)

2. Energy Policy Act of 1992 (*Public Law 102-486*); specifically Section 301, *Definitions*, Section 302, *Amendments to the Energy Policy and Conservation Act*, , Section 303, *Minimum Federal Fleet Requirement*, and Section 304, *Refueling*:

- **DEFINITIONS** – Amended or redefined the language defining alternative fuel, alternative fuel vehicle, light duty vehicle (8,500 GVWR), and fleet (20 or more vehicles).
- **ALTERNATIVE FUEL USE** – Requires federal fleets to use alternative fuels for AFVs unless unattainable.
- **VEHICLE ACQUISITIONS** – By 1999 and thereafter, 75% or more of annual LDV acquisitions will be AFVs.
- **INCREMENTAL COSTS** – When acquiring AFVs, Federal fleets (or procuring agencies) may allocate funds (or obtain payment) in an amount that covers the difference in cost between the purchase of an AFV and a comparable gasoline vehicle.
- **REFUELING** – Required federal fleets to coordinate and maximize the refueling of AFVs by commercial means to promote reductions in petroleum use and emissions.

3. Executive Order 13149 of 2000, Greening the Government through Federal Fleet and Transportation Efficiency; specifically Section 201, *Reduced Petroleum Fuel Consumption*, Section 202(b), *Performance Strategies*, and Section 302, *Designation of Senior Agency Official*:

- **PETROLEUM CONSUMPTION** – By the end of FY 2005, federal fleets are required to decrease their consumption of petroleum by 20% with a 1999 baseline.
- **FUEL ECONOMY** – Federal fleets are required to increase the average mile per gallon (mpg) of LDVs being purchased by at least 1 mpg by the end of FY 2002 and by at least 3 mpg by the end of FY 2005 with a 1999 acquisition baseline.
- **REPORTING** – In addition to the AFV compliance report, federal fleets are required to assign a senior official to assume responsibility of the agency's AFV program and begin reporting vehicle data (i.e. acquisitions, petroleum consumption, fuel efficiency, maintenance, mileage, and other data) into the Federal Automotive Statistical Tool (FAST) tracking system beginning with FY 1999 (baseline) and FY 2000 data.

4. Energy Policy Act of 2005 (Public Law 109-58); specifically Section 701, *Use of Alternative Fuels by Dual Fueled Vehicles* and Section 702, *Incremental Cost Allocation*:

- **ALTERNATIVE FUEL USE** – Enacts new requirement for federal fleets to use alternative fuels for AFVs unless an agency meets Department of Energy (DoE) guidelines for a waiver (i.e. alternative fuel not available within 5 miles or 15 minutes and costs 15% more than regular gasoline).
- **INCREMENTAL COSTS** – Federal fleets are now mandated to allocate AFV incremental costs across their entire fleet vice being optional.

5. Executive Order 13423 of 2007, Strengthening Federal Environmental, Energy, and Transportation Management, (Public Law 110-140; specifically Section 2(g), *Goals for Agencies*:

- **PETROLEUM CONSUMPTION** – Through 2015, decrease petroleum consumption in fleet vehicles by 2% annually with a 2005 baseline.
- **ALTERNATIVE FUEL CONSUMPTION** – Through 2015, increase alternative fuel consumption by 10% annually (compounded annually) with a 2005 baseline.
- **ACQUISITIONS** – Increase the purchase and use of alternative fuel, hybrid, and plug-in hybrid electric vehicles when commercially available.

6. *Energy Independence and Security Act of 2007* (Public Law 110-140); specifically Section 141, *Federal Vehicle Fleets*, Section 142, *Federal Fleet Conservation Requirements*, Section 246, *Federal Fleet Fueling Centers*, Section 526, *Procurement and Acquisition of Alternative Fuels*:

- **FEDERAL FLEETS** – Requires federal agencies to purchase only light and medium duty vehicles that are low greenhouse gas emitting vehicles unless the agency meets DoE guidelines for a waiver.
- **PETROLEUM ALTERNATIVE FUEL CONSUMPTION** – Beginning with FY 2010, federal fleets are required to decrease petroleum consumption by 20% annually and increase the use of alternative fuels by 10% annually through 2015 with a 2005 baseline.
- **FUELING CENTERS** – By FY 2010, federal fleets are required to install at least one renewable fueling pump (does not apply to Department of Defense (DoD) fueling centers consuming less than 100,000 gallons of fuel per year).
- **ALTERNATIVE FUEL ACQUISITIONS** – Restricts federal agencies from purchasing any fuels that are not below green house gas emissions of petroleum based fuels.

7. *National Defense Authorization Act of 2008* (Public Law 110-181); specifically Section 2862, *Definition of Alternative Fuel Vehicle*:

- **DEFINITION** – Amended or redefined the language defining an alternative fuel vehicle.

8. *American Recovery and Reinvestment Act of 2009* (Public Law 111-5); specifically Title III, *Department of Defense*, Subtitle, *General Services Administration*, Subsection, *Energy-Efficient Federal Motor Vehicle Fleet Procurement*:

- **GSA AFV FUNDING** – Available until 30 September 2011, provides \$300 million in funding for capital expenditures and necessary expenses in the acquisition of motor vehicles with higher fuel economy, including: hybrid vehicles, electric vehicles, and plug-in hybrid vehicles.

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APPENDIX C: USMC AFV FLEET SIZE

USMC Alternative Fuel Vehicle Fleet (FY 2008)			
Vehicle Type	Fuel Type	Fuel Capability	Total Inventory
Sedan, Subcompact	CNG	Bi-Fuel	10
Sedan, Subcompact	CNG	Dedicated	44
Sedan, Compact	E-85	Flex-Fuel	381
Sedan, Midsize	E-85	Flex-Fuel	92
Sedan, Large	CNG	Dedicated	3
Pickup 4x2	CNG	Bi-Fuel	108
Pickup 4x2	CNG	Dedicated	106
Pickup 4x2	E-85	Flex-Fuel	414
Pickup 4x4	CNG	Bi-Fuel	65
Pickup 4x4	CNG	Dedicated	45
Pickup 4x4	E-85	Flex-Fuel	133
Pickup 4x4	LPG	Bi-Fuel	3
SUV 4x2	E-85	Flex-Fuel	20
SUV 4x4	E-85	Flex-Fuel	125
Minivan 4x2 (Passenger)	CNG	Dedicated	71
Minivan 4x2 (Passenger)	E-85	Flex-Fuel	899
Minivan 4x2 (Cargo)	E-85	Flex-Fuel	35
Van 4x2 (Passenger)	E-85	Flex-Fuel	130
Van 4x4 (Passenger)	E-85	Flex-Fuel	18
Van 4x2 (Cargo)	CNG	Bi-Fuel	5
Van 4x2 (Cargo)	E-85	Flex-Fuel	14
Bus	CNG	Dedicated	16
Pickup MD	CNG	Bi-Fuel	31
Pickup MD	E-85	Flex-Fuel	1
SUV MD	E-85	Flex-Fuel	3
Van MD (Passenger)	CNG	Bi-Fuel	40
Van MD (Passenger)	CNG	Dedicated	21
Van MD (Passenger)	LPG	Bi-Fuel	3
Van MD (Cargo)	CNG	Bi-Fuel	4
Van MD (Cargo)	CNG	Dedicated	13
Van MD (Cargo)	CNG	Dedicated	4
MD 8,501-16,000 GVWR	CNG	Bi-Fuel	1
MD 8,501-16,000 GVWR	CNG	Dedicated	7
HD 16,001+ GVWR	CNG	Bi-Fuel	1
HD 16,001+ GVWR	CNG	Dedicated	2
Total Number of AFVs			2,868

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APPENDIX D: OMB CIRCULAR NO. A-94

The following is a direct excerpt of the circular

Circular No. A-94 Revised

(Transmittal Memo No. 64)

October 29, 1992

MEMORANDUM FOR HEADS OF EXECUTIVE DEPARTMENTS AND ESTABLISHMENTS

SUBJECT: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs

Table of Contents

- 1. Purpose
- 2. Rescission
- 3. Authority
- 4. Scope
- 5. General Principles
 - a. Net Present Value and Related Outcome Measures
 - b. Cost-Effectiveness Analysis
 - c. Elements of Benefit-Cost or Cost-Effectiveness Analysis
- 6. Identifying and Measuring Benefits and Costs
 - a. Identifying Benefits and Costs
 - b. Measuring Benefits and Costs
- 7. Treatment of Inflation
 - a. Real or Nominal Values
 - b. Recommended Inflation Assumption
- 8. Discount Rate Policy
 - a. Real versus Nominal Discount Rates
 - b. Public Investment and Regulatory Analyses
 - c. Cost-Effectiveness, Lease-Purchase, Internal Government Investment, and Asset Sale Analyses
- 9. Treatment of Uncertainty
 - a. Characterizing Uncertainty
 - b. Expected Values
 - c. Sensitivity Analysis
 - d. Other Adjustments for Uncertainty
- 10. Incidence and Distributional Effects
 - a. Alternative Classifications
 - b. Economic Incidence

11. Special Guidance for Public Investment Analysis
 - a. Analysis of Excess Burdens
 - b. Exceptions
12. Special Guidance for Regulatory Impact Analysis
13. Special Guidance for Lease-Purchase Analysis
 - a. Coverage
 - b. Required Justification for Leases
 - c. Analytical Requirements and Definitions
14. Related Guidance
15. Implementation
16. Effective Date
17. Interpretation

Appendix A: Definitions of Terms

Appendix B: Additional Guidance for Discounting

Appendix C: Discount Rates for Cost-Effectiveness, Lease-Purchase, and Related Analyses

Other Documents

- 1. Purpose.** The goal of this Circular is to promote efficient resource allocation through well-informed decision-making by the Federal Government. It provides general guidance for conducting benefit-cost and cost-effectiveness analyses. It also provides specific guidance on the discount rates to be used in evaluating Federal programs whose benefits and costs are distributed over time. The general guidance will serve as a checklist of whether an agency has considered and properly dealt with all the elements for sound benefit-cost and cost-effectiveness analyses.
- 2. Rescission.** This Circular replaces and rescinds Office of Management and Budget (OMB) Circular No. A-94, "Discount Rates to Be Used in Evaluating Time-Distributed Costs and Benefits," dated March 27, 1972, and Circular No. A-104, "Evaluating Leases of Capital Assets," dated June 1, 1986, which has been rescinded. Lease-purchase analysis is only appropriate after a decision has been made to acquire the services of an asset. Guidance for lease-purchase analysis is provided in Section 8.c.(2) and Section 13.
- 3. Authority.** This Circular is issued under the authority of 31 U.S.C. Section 1111 and the Budget and Accounting Act of 1921, as amended.
- 4. Scope.** This Circular does not supersede agency practices which are prescribed by or pursuant to law, Executive Order, or other relevant circulars. The Circular's guidelines are suggested for use in the internal planning of Executive Branch agencies. The guidelines must be followed in all analyses submitted to OMB in support of legislative and budget-programs in compliance with OMB Circulars No. A-11, "Preparation and Submission of Annual Budget Estimates," and No. A-19, "Legislative Coordination and

Clearance." These guidelines must also be followed in providing estimates submitted to OMB in compliance with Executive Order No. 12291, "Federal Regulation," and the President's April 29, 1992 memorandum requiring benefit-cost analysis for certain legislative proposals.

a. Aside from the exceptions listed below, the guidelines in this Circular apply to any analysis used to support Government decisions to initiate, renew, or expand programs or projects which would result in a series of measurable benefits or costs extending for three or more years into the future. The Circular applies specifically to:

1. Benefit-cost or cost-effectiveness analysis of Federal programs or policies.
2. Regulatory impact analysis.
3. Analysis of decisions whether to lease or purchase.
4. Asset valuation and sale analysis.

b. Specifically exempted from the scope of this Circular are decisions concerning:

1. Water resource projects (guidance for which is the approved *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*).
2. The acquisition of commercial-type services by Government or contractor operation (guidance for which is OMB Circular No. A-76).
3. Federal energy management programs (guidance for which can be found in the *Federal Register* of January 25, 1990, and November 20, 1990).

c. This Circular applies to all agencies of the Executive Branch of the Federal Government. It does not apply to the Government of the District of Columbia or to non-Federal recipients of loans, contracts or grants. Recipients are encouraged, however, to follow the guidelines provided here when preparing analyses in support of Federal activities.

d. For small projects which share similar characteristics, agencies are encouraged to conduct generic studies and to avoid duplication of effort in carrying out economic analysis.

5. General Principles. *Benefit-cost analysis* is recommended as the technique to use in a formal economic analysis of government programs or projects. *Cost-effectiveness analysis* is a less comprehensive technique, but it can be appropriate when the benefits from competing alternatives are the same or where a policy decision has been made that the benefits must be provided. (Appendix A provides a glossary of technical terms used in this Circular; technical terms are italicized when they first appear.)

a. **Net Present Value and Related Outcome Measures.** The standard criterion for deciding whether a government program can be justified on economic principles is *net present value* -- the discounted monetized value of expected net benefits (i.e., benefits

minus costs). Net present value is computed by assigning monetary values to benefits and costs, discounting future benefits and costs using an appropriate discount rate, and subtracting the sum total of discounted costs from the sum total of discounted benefits. Discounting benefits and costs transforms gains and losses occurring in different time periods to a common unit of measurement. Programs with positive net present value increase social resources and are generally preferred. Programs with negative net present value should generally be avoided. (Section 8 considers discounting issues in more detail.) Although net present value is not always computable (and it does not usually reflect effects on income distribution), efforts to measure it can produce useful insights even when the monetary values of some benefits or costs cannot be determined. In these cases:

1. A *comprehensive enumeration* of the different types of benefits and costs, monetized or not, can be helpful in identifying the full range of program effects.
2. *Quantifying* benefits and costs is worthwhile, even when it is not feasible to assign monetary values; *physical measurements* may be possible and useful. Other **summary effectiveness measures** can provide useful supplementary information to net present value, and analysts are encouraged to report them also. Examples include the number of injuries prevented per dollar of cost (both measured in present value terms) or a project's internal rate of return.

b. **Cost-Effectiveness Analysis.** A program is cost-effective if, on the basis of *life cycle cost* analysis of competing alternatives, it is determined to have the lowest costs expressed in present value terms for a given amount of benefits. Cost effectiveness analysis is appropriate whenever it is unnecessary or impractical to consider the dollar value of the benefits provided by the alternatives under consideration. This is the case whenever (i) each alternative has the same annual benefits expressed in monetary terms; or (ii) each alternative has the same annual affects, but dollar values cannot be assigned to their benefits. Analysis of alternative defense systems often falls in this category.

Cost-effectiveness analysis can also be used to compare programs with identical costs but differing benefits. In this case, the decision criterion is the discounted present value of benefits. The alternative program with the largest benefits would normally be favored.

c. **Elements of Benefit-Cost or Cost-Effectiveness Analysis.**

1. **Policy Rationale.** The rationale for the Government program being examined should be clearly stated in the analysis. Programs may be justified on efficiency grounds where they address market failure, such as public goods and externalities. They may also be justified where they improve the efficiency of the Government's internal operations, such as cost-saving investments.

2. **Explicit Assumptions.** Analyses should be explicit about the underlying assumptions used to arrive at estimates of future benefits and costs. In the case of public health programs, for example, it may be necessary to make assumptions about the number of future beneficiaries, the intensity of service, and the rate of increase in medical prices. The analysis should include a statement of the assumptions, the rationale behind them, and a review of their strengths and weaknesses. Key data and results, such as year-by-year estimates of benefits and costs, should be reported to promote independent analysis and review.
3. **Evaluation of Alternatives.** Analyses should also consider alternative means of achieving program objectives by examining different program *scales*, different *methods* of provision, and different degrees of government *involvement*. For example, in evaluating a decision to acquire a capital asset, the analysis should generally consider: (i) doing nothing; (ii) direct purchase; (iii) upgrading, renovating, sharing, or converting existing government property; or (iv) leasing or contracting for services.
4. **Verification.** Retrospective studies to determine whether anticipated benefits and costs have been realized are potentially valuable. Such studies can be used to determine necessary corrections in existing programs, and to improve future estimates of benefits and costs in these programs or related ones. Agencies should have a plan for periodic, results oriented evaluation of program effectiveness. They should also discuss the results of relevant evaluation studies when proposing reauthorizations or increased program funding.
6. **Identifying and Measuring Benefits and Costs.** Analyses should include comprehensive estimates of the expected benefits and costs to *society* based on established definitions and practices for program and policy evaluation. Social net benefits, and not the benefits and costs to the Federal Government, should be the basis for evaluating government programs or policies that have effects on private citizens or other levels of government. Social benefits and costs can differ from private benefits and costs as measured in the marketplace because of imperfections arising from: (i) *external economies or diseconomies* where actions by one party impose benefits or costs on other groups that are not compensated in the market place; (ii) monopoly power that distorts the relationship between marginal costs and market prices; and (iii) taxes or subsidies.
 - a. **Identifying Benefits and Costs.** Both intangible and tangible benefits and costs should be recognized. The relevant cost concept is broader than private-sector production and compliance costs or government cash expenditures. Costs should reflect the opportunity cost of any resources used, measured by the return to those resources in their most productive application elsewhere. Below are some guidelines to consider when identifying benefits and costs.

- **Incremental Benefits and Costs.** Calculation of net present value should be based on incremental benefits and costs. Sunk costs and realized benefits should be ignored. Past experience is relevant only in helping to estimate what the value of future benefits and costs might be. Analyses should take particular care to identify the extent to which a policy such as a subsidy program promotes substitutes for activities of a similar nature that would occur without the policy. Either displaced activities should be explicitly recorded as costs or only incremental gains should be recorded as benefits of the policy.
- **Interactive Effects.** Possible interactions between the benefits and costs being analyzed and other government activities should be considered. For example, policies affecting agricultural output should reflect real economic values, as opposed to subsidized prices.
- **International Effects.** Analyses should focus on benefits and costs accruing to the citizens of the United States in determining net present value. Where programs or projects have effects outside the United States, these effects should be reported separately.
- **Transfers.** There are no economic gains from a pure *transfer payment* because the benefits to those who receive such a transfer are matched by the costs borne by those who pay for it. Therefore, transfers should be excluded from the calculation of net present value. Transfers that arise as a result of the program or project being analyzed should be identified as such, however, and their distributional effects discussed. It should also be recognized that a transfer program may have benefits that are less than the program's real economic costs due to inefficiencies that can arise in the program's delivery of benefits and financing.

b. **Measuring Benefits and Costs.** The principle of *willingness-to-pay* provides an aggregate measure of what individuals are willing to forego to obtain a given benefit. Market prices provide an invaluable starting point for measuring willingness-to-pay, but prices sometimes do not adequately reflect the true value of a good to society. Externalities, monopoly power, and taxes or subsidies can distort market prices. Taxes, for example, usually create an *excess burden* that represents a net loss to society. (The appropriate method for recognizing this excess burden in public investment analyses is discussed in Section 11.) In other cases, market prices do not exist for a relevant benefit or cost. When market prices are distorted or unavailable, other methods of valuing benefits may have to be employed. Measures derived from actual market behavior are preferred when they are available.

1. **Inframarginal Benefits and Costs.** Consumers would generally be willing to pay more than the market price rather than go entirely without a good they consume. The economist's concept of *consumer surplus* measures the extra value

consumers derive from their consumption compared with the value measured at market prices. When it can be determined, consumer surplus provides the best measure of the total benefit to society from a government program or project. Consumer surplus can sometimes be calculated by using econometric methods to estimate consumer demand.

2. Indirect Measures of Benefits and Costs. Willingness-to-pay can sometimes be estimated indirectly through changes in land values, variations in wage rates, or other methods. Such methods are most reliable when they are based on actual market transactions. Measures should be consistent with basic economic principles and should be replicable.

3. Multiplier Effects. Generally, analyses should treat resources as if they were likely to be fully employed. Employment or output multipliers that purport to measure the secondary effects of government expenditures on employment and output should not be included in measured social benefits or costs.

7. Treatment of Inflation. Future inflation is highly uncertain. Analysts should avoid having to make an assumption about the general rate of inflation whenever possible.

a. Real or Nominal Values. Economic analyses are often most readily accomplished using *real* or *constant-dollar* values, i.e., by measuring benefits and costs in units of stable purchasing power. (Such estimates may reflect expected future changes in relative prices, however, where there is a reasonable basis for estimating such changes.) Where future benefits and costs are given in *nominal* terms, i.e., in terms of the future purchasing power of the dollar, the analysis should use these values rather than convert them to constant dollars as, for example, in the case of lease-purchase analysis. Nominal and real values must not be combined in the same analysis. Logical consistency requires that analysis be conducted either in constant dollars or in terms of nominal values. This may require converting some nominal values to real values, or vice versa.

b. Recommended Inflation Assumption. When a general inflation assumption is needed, the rate of increase in the Gross Domestic Product deflator from the Administration's economic assumptions for the period of the analysis is recommended. For projects or programs that extend beyond the six-year budget horizon, the inflation assumption can be extended by using the inflation rate for the sixth year of the budget forecast. The Administration's economic forecast is updated twice annually, at the time the budget is published in January or February and at the time of the Mid-Session Review of the Budget in July. Alternative inflation estimates, based on credible private sector forecasts, may be used for sensitivity analysis.

8. Discount Rate Policy. In order to compute net present value, it is necessary to discount future benefits and costs. This discounting reflects the time value of money. Benefits and costs are worth more if they are experienced sooner. All future benefits and

costs, including nonmonetized benefits and costs, should be discounted. The higher the discount rate, the lower is the present value of future cash flows. For typical investments, with costs concentrated in early periods and benefits following in later periods, raising the discount rate tends to reduce the net present value. (Technical guidance on discounting and a table of *discount factors* are provided in Appendix B.)

a. **Real versus Nominal Discount Rates.** The proper discount rate to use depends on whether the benefits and costs are measured in real or nominal terms.

1. A real discount rate that has been adjusted to eliminate the effect of expected inflation should be used to discount constant-dollar or real benefits and costs. A real discount rate can be approximated by subtracting expected inflation from a nominal interest rate.
2. A nominal discount rate that reflects expected inflation should be used to discount nominal benefits and costs. Market interest rates are nominal interest rates in this sense.

b. **Public Investment and Regulatory Analyses.** The guidance in this section applies to benefit-cost analyses of public investments and regulatory programs that provide benefits and costs to the general public. Guidance related to cost-effectiveness analysis of internal planning decisions of the Federal Government is provided in Section 8.c.

In general, public investments and regulations displace both private investment and consumption. To account for this displacement and to promote efficient investment and regulatory policies, the following guidance should be observed.

1. **Base-Case Analysis.** Constant-dollar benefit-cost analyses of proposed investments and regulations should report net present value and other outcomes determined using a real discount rate of 7 percent. This rate approximates the marginal pretax rate of return on an average investment in the private sector in recent years. Significant changes in this rate will be reflected in future updates of this Circular.

2. **Other Discount Rates.** Analyses should show the sensitivity of the discounted net present value and other outcomes to variations in the discount rate. The importance of these alternative calculations will depend on the specific economic characteristics of the program under analysis. For example, in analyzing a regulatory proposal whose main cost is to reduce business investment, net present value should also be calculated using a higher discount rate than 7 percent.

Analyses may include among the reported outcomes the *internal rate of return* implied by the stream of benefits and costs. The internal rate of return is the discount rate that sets the net present value of the program or project to zero.

While the internal rate of return does not generally provide an acceptable decision criterion, it does provide useful information, particularly when budgets are constrained or there is uncertainty about the appropriate discount rate.

3. Using the *shadow price of capital* to value benefits and costs is the analytically preferred means of capturing the effects of government projects on resource allocation in the private sector. To use this method accurately, the analyst must be able to compute how the benefits and costs of a program or project affect the allocation of private consumption and investment. OMB concurrence is required if this method is used in place of the base case discount rate.

c. **Cost-Effectiveness, Lease-Purchase, Internal Government Investment, and Asset Sales Analyses.** The Treasury's borrowing rates should be used as discount rates in the following cases:

1. **Cost-Effectiveness Analysis.** Analyses that involve constant-dollar costs should use the real Treasury borrowing rate on marketable securities of comparable maturity to the period of analysis. This rate is computed using the Administration's economic assumptions for the budget, which are published in January of each year. A table of discount rates based on the expected interest rates for the first year of the budget forecast is presented in Appendix C of this Circular. Appendix C is updated annually and is available upon request from OMB. Real Treasury rates are obtained by removing expected inflation over the period of analysis from nominal Treasury interest rates. (Analyses that involve nominal costs should use nominal Treasury rates for discounting, as described in the following paragraph.)

2. **Lease-Purchase Analysis.** Analyses of nominal lease payments should use the nominal Treasury borrowing rate on marketable securities of comparable maturity to the period of analysis. Nominal Treasury borrowing rates should be taken from the economic assumptions for the budget. A table of discount rates based on these assumptions is presented in Appendix C of this Circular, which is updated annually. (Constant dollar lease-purchase analyses should use the real Treasury borrowing rate, described in the preceding paragraph.)

3. **Internal Government Investments.** Some Federal investments provide "internal" benefits which take the form of increased Federal revenues or decreased Federal costs. An example would be an investment in an energy-efficient building system that reduces Federal operating costs. Unlike the case of a Federally funded highway (which provides "external" benefits to society as a whole), it is appropriate to calculate such a project's net present value using a comparable-maturity Treasury rate as a discount rate. The rate used may be either nominal or real, depending on how benefits and costs are measured.

Some Federal activities provide a mix of both Federal cost savings and external social benefits. For example, Federal investments in information technology can produce Federal savings in the form of lower administrative costs and external social benefits in the form of faster claims processing. The net present value of such investments should be evaluated with the 7 percent real discount rate discussed in Section 8.b. unless the analysis is able to allocate the investment's costs between provision of Federal cost savings and external social benefits. Where such an allocation is possible, Federal cost savings and their associated investment costs may be discounted at the Treasury rate, while the external social benefits and their associated investment costs should be discounted at the 7 percent real rate.

4. Asset Sale Analysis. Analysis of possible asset sales should reflect the following:

- (a) The net present value to the Federal Government of holding an asset is best measured by discounting its future earnings stream using a Treasury rate. The rate used may be either nominal or real, depending on how earnings are measured.
- (b) Analyses of government asset values should explicitly deduct the cost of expected defaults or delays in payment from projected cash flows, along with government administrative costs. Such analyses should also consider explicitly the probabilities of events that would cause the asset to become nonfunctional, impaired or obsolete, as well as probabilities of events that would increase asset value.
- (c) Analyses of possible asset sales should assess the gain in social efficiency that can result when a government asset is subject to market discipline and private incentives. Even though a government asset may be used more efficiently in the private sector, potential private-sector purchasers will generally discount such an asset's earnings at a rate in excess of the Treasury rate, in part, due to the cost of bearing risk. When there is evidence that government assets can be used more efficiently in the private sector, valuation analyses for these assets should include sensitivity comparisons that discount the returns from such assets with the rate of interest earned by assets of similar riskiness in the private sector.

9. Treatment of Uncertainty. Estimates of benefits and costs are typically uncertain because of imprecision in both underlying data and modeling assumptions. Because such uncertainty is basic to many analyses, its effects should be analyzed and reported. Useful information in such a report would include the key sources of uncertainty; expected value estimates of outcomes; the sensitivity of results to important sources of uncertainty; and where possible, the probability distributions of benefits, costs, and net benefits.

- a. **Characterizing Uncertainty.** Analyses should attempt to characterize the sources and nature of uncertainty. Ideally, probability distributions of potential benefits, costs, and net benefits should be presented. It should be recognized that many phenomena that are treated as deterministic or certain are, in fact, uncertain. In analyzing uncertain data, objective estimates of probabilities should be used whenever possible. Market data, such as private insurance payments or interest rate differentials, may be useful in identifying and estimating relevant risks. Stochastic simulation methods can be useful for analyzing such phenomena and developing insights into the relevant probability distributions. In any case, the basis for the probability distribution assumptions should be reported. Any limitations of the analysis because of uncertainty or biases surrounding data or assumptions should be discussed.
- b. **Expected Values.** The expected values of the distributions of benefits, costs and net benefits can be obtained by weighting each outcome by its probability of occurrence, and then summing across all potential outcomes. If estimated benefits, costs and net benefits are characterized by point estimates rather than as probability distributions, the expected value (an unbiased estimate) is the appropriate estimate for use. Estimates that differ from expected values (such as worst-case estimates) may be provided in addition to expected values, but the rationale for such estimates must be clearly presented. For any such estimate, the analysis should identify the nature and magnitude of any bias. For example, studies of past activities have documented tendencies for cost growth beyond initial expectations; analyses should consider whether past experience suggests that initial estimates of benefits or costs are optimistic.
- c. **Sensitivity Analysis.** Major assumptions should be varied and net present value and other outcomes recomputed to determine how sensitive outcomes are to changes in the assumptions. The assumptions that deserve the most attention will depend on the dominant benefit and cost elements and the areas of greatest uncertainty of the program being analyzed. For example, in analyzing a retirement program, one would consider changes in the number of beneficiaries, future wage growth, inflation, and the discount rate. In general, sensitivity analysis should be considered for estimates of: (i) benefits and costs; (ii) the discount rate; (iii) the general inflation rate; and (iv) distributional assumptions. Models used in the analysis should be well documented and, where possible, available to facilitate independent review.
- d. **Other Adjustments for Uncertainty.** The absolute variability of a risky outcome can be much less significant than its correlation with other significant determinants of social welfare, such as real national income. In general, variations in the discount rate are not the appropriate method of adjusting net present value for the special risks of particular projects. In some cases, it may be possible to estimate *certainty-equivalents* which involve adjusting uncertain expected values to account for risk.

10. Incidence and Distributional Effects. The principle of maximizing net present value of benefits is based on the premise that gainers could fully compensate the losers and still

be better off. The presence or absence of such compensation should be indicated in the analysis. When benefits and costs have significant distributional effects, these effects should be analyzed and discussed, along with the analysis of net present value. (This will not usually be the case for cost-effectiveness analysis where the scope of government activity is not changing.)

a. **Alternative Classification.** Distributional effects may be analyzed by grouping individuals or households according to income class (e.g., income quintiles), geographical region, or demographic group (e.g., age). Other classifications, such as by industry or occupation, may be appropriate in some circumstances. Analysis should aim at identifying the relevant gainers and losers from policy decisions. Effects on the preexisting assignment of property rights by the program under analysis should be reported. Where a policy is intended to benefit a specified subgroup of the population, such as the poor, the analysis should consider how effective the policy is in reaching its targeted group.

b. **Economic Incidence.** Individuals or households are the ultimate recipients of income; business enterprises are merely intermediaries. Analyses of distribution should identify economic incidence, or how costs and benefits are ultimately borne by households or individuals. Determining economic incidence can be difficult because benefits and costs are often redistributed in unintended and unexpected ways. For example, a subsidy for the production of a commodity will usually raise the incomes of the commodity's suppliers, but it can also benefit consumers of the commodity through lower prices and reduce the incomes for suppliers of competing products. A subsidy also raises the value of specialized resources used in the production of the subsidized commodity. As the subsidy is incorporated in asset values, its distributional effects can change.

11. **Special Guidance for Public Investment.** This guidance applies only to public investments with social benefits apart from decreased Federal costs. It is not required for cost-effectiveness or lease-purchase analyses. Because taxes generally distort relative prices, they impose a burden in excess of the revenues they raise. Recent studies of the U.S. tax system suggest a range of values for the marginal excess burden, of which a reasonable estimate is 25 cents per dollar of revenue.

a. **Analysis of Excess Burdens.** The presentation of results for public investments that are not justified on cost-saving grounds should include a supplementary analysis with a 25 percent excess burden. Thus, in such analyses, costs in the form of public expenditures should be multiplied by a factor of 1.25 and net present value recomputed.

b. **Exceptions.** Where specific information clearly suggests that the excess burden is lower (or higher) than 25 percent, analyses may use a different figure. When a different figure is used, an explanation should be provided for it. An example of such an exception is an investment funded by user charges that function like market prices; in this case, the

excess burden would be zero. Another example would be a project that provides both cost savings to the Federal Government and external social benefits. If it is possible to make a quantitative determination of the portion of this project's costs that give rise to Federal savings, that portion of the costs may be exempted from multiplication by the factor of 1.25.

12. Special Guidance for Regulatory Impact Analysis. Additional guidance for analysis of regulatory policies is provided in *Regulatory Program of the United States Government* which is published annually by OMB. (See "Regulatory Impact Analysis Guidance," Appendix V of *Regulatory Program of the United States Government* for April 1, 1991 to March 31, 1992.)

13. Special Guidance for Lease-Purchase Analysis. The special guidance in this section does not apply to the decision to acquire the use of an asset. In deciding that, the agency should conduct a benefit-cost analysis, if possible. Only after the decision to acquire the services of an asset has been made is there a need to analyze the decision whether to lease or purchase.

a. Coverage. The Circular applies only when both of the following tests of applicability are satisfied:

1. The lease-purchase analysis concerns a capital asset, (including durable goods, equipment, buildings, facilities, installations, or land) which:

(a) Is leased to the Federal Government for a term of three or more years; or,

(b) Is new, with an economic life of less than three years, and leased to the Federal Government for a term of 75 percent or more of the economic life of the asset; or,

(c) Is built for the express purpose of being leased to the Federal Government; or,

(d) Is leased to the Federal Government and clearly has no alternative commercial use (e.g., a special-purpose government installation).

2. The lease-purchase analysis concerns a capital asset or a group of related assets whose total fair market value exceeds \$1 million.

b. Required Justification for Leases. All leases of capital assets must be justified as preferable to direct government purchase and ownership. This can be done in one of three ways:

1. By conducting a separate lease-purchase analysis. This is the only acceptable method for major acquisitions. A lease represents a major acquisition if:
 - (a) The acquisition represents a separate line-item in the agency's budget;
 - (b) The agency or OMB determines the acquisition is a major one; or
 - (c) The total purchase price of the asset or group of assets to be leased would exceed \$500 million.
2. By conducting periodic lease-purchase analyses of recurrent decisions to lease similar assets used for the same general purpose. Such analyses would apply to the entire class of assets. OMB approval should be sought in determining the scope of any such generic analysis.
3. By adopting a formal policy for smaller leases and submitting that policy to the OMB for approval. Following such a policy should generally result in the same lease-purchase decisions as would conducting separate lease-purchase analyses. Before adopting the policy, it should be demonstrated that:
 - (a) The leases in question would generally result in substantial savings to the Government that could not be realized on a purchase;
 - (b) The leases are so small or so short-term as to make separate lease-purchase analysis impractical; and
 - (c) Leases of different types are scored consistently with the instructions in Appendices B and C of OMB Circular No. A-11.

c. **Analytical Requirements and Definitions.** Whenever a Federal agency needs to acquire the use of a capital asset, it should do so in the way that is least expensive for the Government as a whole.

1. **Life-Cycle Cost.** Lease-purchase analyses should compare the net discounted present value of the life-cycle cost of leasing with the full costs of buying or constructing an identical asset. The full costs of buying include the asset's purchase price plus the net discounted present value of any relevant ancillary services connected with the purchase. (Guidance on the discount rate to use for lease-purchase analysis is in Section 8.c.)
2. **Economic Life.** For purposes of lease-purchase analysis, the economic life of an asset is its remaining or productive lifetime. It begins when the asset is acquired and ends when the asset is retired from service. The economic life is frequently not the same as the useful life for tax purposes.

3. Purchase Price. The purchase price of the asset for purposes of lease-purchase analysis is its fair market value, defined as the price a willing buyer could reasonably expect to pay a willing seller in a competitive market to acquire the asset.

(a) In the case of property that is already owned by the Federal Government or that has been donated or acquired by condemnation, an imputed purchase price should be estimated. (Guidance on making imputations is provided in Section 13.c.(6).).

(b) If public land is used for the site of the asset, the imputed market value of the land should be added to the purchase price.

(c) The asset's estimated residual value, as of the end of the period of analysis, should be subtracted from its purchase price. (Guidance on estimating residual value is provided in Section 13.c.(7).)

4. Taxes. In analyzing the cost of a lease, the normal payment of taxes on the lessor's income from the lease should not be subtracted from the lease costs since the normal payment of taxes will also be reflected in the purchase cost. The cost to the Treasury of special tax benefits, if any, associated with the lease should be added to the cost of the lease. Examples of such tax benefits might include highly accelerated depreciation allowances or tax-free financing.

5. Ancillary Services. If the terms of the lease include ancillary services provided by the lessor, the present value of the cost of obtaining these services separately should be added to the purchase price. Such costs may be excluded if they are estimated to be the same for both lease and purchase alternatives or too small to affect the comparison. Examples of ancillary services include:

(a) All costs associated with acquiring the property and preparing it for use, including construction, installation, site, design, and management costs.

(b) Repair and improvement costs (if included in lease payments).

(c) Operation and maintenance costs (if included in lease payments).

(d) Imputed property taxes (excluding foreign property taxes on overseas acquisitions except where actually paid). The imputed taxes approximate the costs of providing municipal services such as water, sewage, and police and fire protection. (See Section (6) below.)

(e) Imputed insurance premiums. (See Section (6) below.)

6. Estimating Imputed Costs. Certain costs associated with the Federal purchase of an asset may not involve a direct monetary payment. Some of these imputed costs may be estimated as follows.

(a) **Purchase Price.** An imputed purchase price for an asset that is already owned by the Federal Government or which has been acquired by donation or condemnation should be based on the fair market value of similar properties that have been traded on commercial markets in the same or similar localities. The same method should be followed in estimating the imputed value of any Federal land used as a site for the asset.

(b) **Property Taxes.** Imputed property taxes may be estimated in two ways.

(i) Determine the property tax rate and assessed (taxable) value for comparable property in the intended locality. If there is no basis on which to estimate future changes in tax rates or assessed values, the first- year tax rate and assessed value (inflation adjusted for each subsequent year) can be applied to all years. Multiply the assessed value by the tax rate to determine the annual imputation for property taxes.

(ii) As an alternative to step (i) above, obtain an estimate of the current local effective property tax rate from the Building Owners and Managers Association's Regional Exchange Reports. Multiply the fair market value of the government-owned property (inflation adjusted for each year) by the effective tax rate.

(c) **Insurance Premiums.** Determine local estimates of standard commercial coverage for similar property from the Building Owners and Managers Association's Regional Exchange Reports.

7. Residual Value. A property's residual value is an estimate of the price that the property could be sold for at the end of the period of the lease-purchase analysis, measured in discounted present value terms.

(a) The recommended way to estimate residual value is to determine what similar, comparably aged property is currently selling for in commercial markets.

(b) Alternatively, book estimates of the resale value of used property may be available from industry or government sources.

(c) Assessed values of similar, comparably aged properties determined for property tax purposes may also be used.

8. Renewal Options. In determining the term of a lease, all renewal options shall be added to the initial lease period.

14. Related Guidance.

a. OMB Circular No. A-11,"Preparation and Submission of Annual Budget Estimates."

b. OMB Circular No. A-19,"Legislative Coordination and Clearance."

c. OMB Circular No. A-70,"Federal Credit Policy."

d. OMB Circular No. A-76,"Performance of Commercial Activities."

e. OMB Circular No. A-109,"Policies to Be Followed in the Acquisition of Major Systems."

f. OMB Circular No. A-130,"Management of Federal Information Resources."

g. "Joint OMB and Treasury Guidelines to the Department of Defense Covering Lease or Charter Arrangements for Aircraft and Naval Vessels."

h. Executive Order 12291, "Federal Regulation."

i. "Regulatory Impact Analysis Guidance," in *Regulatory Program of the United States Government*.

j. "Federal Energy Management and Planning Programs; Life Cycle Cost Methodology and Procedures,"

k. Federal Register, Vol. 55, No. 17, January 25, 1990, and Vol. 55, No. 224, November 20, 1990.

l. Presidential Memorandum of April 29, 1992, "Benefits and Costs of Legislative Proposals."

15. Implementation. Economic analyses submitted to OMB will be reviewed for conformity with Items 5 to 13 in this Circular, through the Circular No. A-11 budget justification and submission process, and Circular No. A-19,legislative review process.

16. Effective Date. This Circular is effective immediately.

17. **Interpretation.** Questions concerning interpretation of this Circular should be addressed to the Office of Economic Policy, Office of Management and Budget (202-395-5873) or, in the case of regulatory issues and analysis, to the Office of Information and Regulatory Affairs (202-395-4852).

APPENDIX A

DEFINITION OF TERMS

Benefit-Cost Analysis -- A systematic quantitative method of assessing the desirability of government projects or policies when it is important to take a long view of future effects and a broad view of possible side-effects.

Capital Asset -- Tangible property, including durable goods, equipment, buildings, installations, and land.

Certainty-Equivalent -- A certain (i.e., nonrandom) outcome that an individual values equally to an uncertain outcome. For a risk averse individual, the certainty-equivalent for an uncertain set of benefits may be less than the mathematical expectation of the outcome; for example, an individual may value a 50-50 chance of winning \$100 or \$0 as only \$45. Analogously, a risk-averse individual may have a certainty-equivalent for an uncertain set of costs that is larger in magnitude than the mathematical expectation of costs.

Cost-Effectiveness -- A systematic quantitative method for comparing the costs of alternative means of achieving the same stream of benefits or a given objective.

Consumer Surplus -- The maximum sum of money a consumer would be willing to pay to consume a given amount of a good, less the amount actually paid. It is represented graphically by the area between the demand curve and the price line in a diagram representing the consumer's demand for the good as a function of its price.

Discount Rate -- The interest rate used in calculating the present value of expected yearly benefits and costs.

Discount Factor -- The factor that translates expected benefits or costs in any given future year into present value terms. The discount factor is equal to $1/(1 + i)t$ where i is the interest rate and t is the number of years from the date of initiation for the program or policy until the given future year.

Excess Burden -- Unless a tax is imposed in the form of a lump sum unrelated to economic activity, such as a head tax, it will affect economic decisions on the margin. Departures from economic efficiency resulting from the distorting effect of taxes are

called excess burdens because they disadvantage society without adding to Treasury receipts. This concept is also sometimes referred to as deadweight loss.

External Economy or Diseconomy -- A direct effect, either positive or negative, on someone's profit or welfare arising as a byproduct of some other person's or firm's activity. Also referred to as neighborhood or spillover effects, or externalities for short.

Incidence -- The ultimate distributional effect of a tax, expenditure, or regulatory program.

Inflation -- The proportionate rate of change in the general price level, as opposed to the proportionate increase in a specific price. Inflation is usually measured by a broad-based price index, such as the implicit deflator for Gross Domestic Product or the Consumer Price Index.

Internal Rate of Return -- The discount rate that sets the net present value of the stream of net benefits equal to zero. The internal rate of return may have multiple values when the stream of net benefits alternates from negative to positive more than once.

Life Cycle Cost -- The overall estimated cost for a particular program alternative over the time period corresponding to the life of the program, including direct and indirect initial costs plus any periodic or continuing costs of operation and maintenance.

Multiplier -- The ratio between the direct effect on output or employment and the full effect, including the effects of second order rounds or spending. Multiplier effects greater than 1.0 require the existence of involuntary unemployment.

Net Present Value -- The difference between the discounted present value of benefits and the discounted present value of costs.

Nominal Values -- Economic units measured in terms of purchasing power of the date in question. A nominal value reflects the effects of general price inflation.

Nominal Interest Rate -- An interest rate that is not adjusted to remove the effects of actual or expected inflation. Market interest rates are generally nominal interest rates.

Opportunity Cost -- The maximum worth of a good or input among possible alternative uses.

Real or Constant Dollar Values -- Economic units measured in terms of constant purchasing power. A real value is not affected by general price inflation. Real values can be estimated by deflating nominal values with a general price index, such as the implicit deflator for Gross Domestic Product or the Consumer Price Index.

Real Interest Rate -- An interest rate that has been adjusted to remove the effect of expected or actual inflation. Real interest rates can be approximated by subtracting the expected or actual inflation rate from a nominal interest rate. (A precise estimate can be obtained by dividing one plus the nominal interest rate by one plus the expected or actual inflation rate, and subtracting one from the resulting quotient.)

Relative Price -- A price ratio between two goods as, for example, the ratio of the price of energy to the price of equipment.

Shadow Price -- An estimate of what the price of a good or input would be in the absence of market distortions, such as externalities or taxes. For example, the shadow price of capital is the present value of the social returns to capital (before corporate income taxes) measured in units of consumption.

Sunk Cost -- A cost incurred in the past that will not be affected by any present or future decision. Sunk costs should be ignored in determining whether a new investment is worthwhile.

Transfer Payment -- A payment of money or goods. A pure transfer is unrelated to the provision of any goods or services in exchange. Such payments alter the distribution of income, but do not directly affect the allocation of resources on the margin.

Treasury Rates -- Rates of interest on marketable Treasury debt. Such debt is issued in maturities ranging from 91 days to 30 years.

Willingness to Pay -- The maximum amount an individual would be willing to give up in order to secure a change in the provision of a good or service.

APPENDIX B

ADDITIONAL GUIDANCE FOR DISCOUNTING

1. Sample Format for Discounting Deferred Costs and Benefits

Assume a 10-year program which will commit the Government to the stream of real (or constant-dollar) expenditures appearing in column (2) of the table below and which will result in a series of real benefits appearing in column (3). The discount factor for a 7 percent discount rate is shown in column (4). The present value cost for each of the 10 years is calculated by multiplying column (2) by column (4); the present value benefit for each of the 10 years is calculated by multiplying column (3) by column (4). The present values of costs and benefits are presented in columns (5) and (6) respectively.

Year since initiation renewal or expansion (1)	Expected yearly cost (2)	Expected yearly benefit (3)	Discount factors for 7% (4)	Present value of costs Col. 2 x Col. 4 (5)	Present value of benefits Col. 3 x Col. 4 (6)
1	\$10.00	\$ 0.00	0.9346	\$ 9.35	\$0.00
2	20.00	0.00	0.8734	17.47	0.00
3	30.00	5.00	0.8163	24.49	4.08
4	30.00	10.00	0.7629	22.89	7.63
5	20.00	30.00	0.7130	14.26	21.39
6	10.00	40.00	0.6663	6.66	26.65
7	5.00	40.00	0.6227	3.11	24.91
8	5.00	40.00	0.5820	2.91	23.28
9	5.00	40.00	0.5439	2.72	21.76
10	5.00	25.00	0.5083	2.54	12.71
Total				\$106.40	\$142.41

NOTE: The discount factor is calculated as $1/(1 + i)t$ where i is the interest rate (.07) and t is the year.

The sum of column (5) is the total present value of costs and the sum of column (6) is the total present value of benefits. Net present value is \$36.01, the difference between the sum of discounted benefits and the sum of discounted costs.

2. End-of-Year and Mid-Year Discount Factors

The discount factors presented in the table above are calculated on the implicit assumption that costs and benefits occur as lump sums at year-end. When costs and benefits occur in a steady stream, applying mid-year discount factors is more appropriate. For instance, the first cost in the table may be estimated to occur after six months, rather than at the end of one year to approximate better a steady stream of costs and benefits occurring over the first year. Similarly, it may be assumed that all other costs and benefits are advanced six months to approximate better a continuing steady flow.

The present values of costs and benefits computed from the table above can be converted to a mid-year discounting basis by multiplying them by 1.0344 (the square root of 1.07). Thus, if the above example were converted to a mid-year basis, the present value of costs would be \$110.06, the present value of benefits would be \$147.31, and the net present value would be \$37.25.

3. Illustrative Discount Factors for Discount Rate of 7 percent

Year since inflation, Renewal or Expansion	Year-end Discount Factors	Mid-Year Discount Factors	Beg-of-year Discount Factors
1	0.9346	0.9667	1
2	0.8734	0.9035	0.9346
3	0.8163	0.8444	0.8734
4	0.7629	0.7891	0.8163
5	0.713	0.7375	0.7629
6	0.6663	0.6893	0.713
7	0.582	0.602	0.6227
8	0.5439	0.5626	0.582
9	0.5083	0.5258	0.5439
10	0.4751	0.4914	0.5083
11	0.444	0.4593	0.4751
12	0.415	0.4292	0.444
13	0.3878	0.4012	0.415
14	0.3624	0.3749	0.3878
15	0.3387	0.3504	0.3624
16	0.3166	0.3275	0.3387
17	0.2959	0.306	0.3166
18	0.2765	0.286	0.2959
19	0.2584	0.2673	0.2765
20	0.2584	0.2673	0.2584
21	0.2415	0.2498	0.2584
22	0.2257	0.2335	0.2415
23	0.2109	0.2182	0.2257
24	0.1971	0.2039	0.2109
25	0.1842	0.1906	0.1971
26	0.1722	0.1781	0.1842
27	0.1609	0.1665	0.1722
28	0.1504	0.1556	0.1609
29	0.1406	0.1454	0.1504
30	0.1314	0.1359	0.1406

APPENDIX C
Revised December 2008

**DISCOUNT RATES FOR COST-EFFECTIVENESS, LEASE PURCHASE,
AND RELATED ANALYSES**

Effective Dates. This appendix is updated annually around the time of the President's budget submission to Congress. This version of the appendix is valid for calendar year 2009. A copy of the updated appendix can be obtained in electronic form through the OMB home page at http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html, the text of the main body of the Circular is found at <http://www.whitehouse.gov/omb/circulars/a094/a094.html>, and a table of past years' rates is located at <http://www.whitehouse.gov/omb/circulars/a094/disclist.pdf>. Updates of the appendix are also available upon request from OMB's Office of Economic Policy (202-395-3381).

Nominal Discount Rates. A forecast of nominal or market interest rates for 2009 based on the economic assumptions for the 2010 Budget are presented below. These nominal rates are to be used for discounting nominal flows, which are often encountered in lease-purchase analysis.

Nominal Rates on Treasury Notes and Bonds of Specified Maturities (in percent):

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
2.7	3.3	3.7	4.2	4.7	4.5

Real Discount Rates. A forecast of real interest rates from which the inflation premium has been removed and based on the economic assumptions from the 2010 Budget is presented below. These real rates are to be used for discounting constant-dollar flows, as is often required in cost-effectiveness analysis.

Real Interest Rates on Treasury Notes and Bonds of Specified Maturities (in percent):

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
0.9	1.6	1.9	2.4	2.9	2.7

Analyses of programs with terms different from those presented above may use a linear interpolation. For example, a four-year project can be evaluated with a rate equal to the average of the three-year and five-year rates. Programs with durations longer than 30 years may use the 30-year interest rate. (Circular No. A-94: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, 1992)

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APPENDIX E: NCCA INFLATION RATE INDEX/RAW INDICES

Table E-1 shows the inflation rates and raw indices used for the purchase alternative and are based on the PMC = Procurement, Marine Corps (1109) appropriation category with a base year of 2009:

Table E-1: Inflation rates/Raw Indices, Base Year 2009, PMC Appropriation Category

PMC = Procurement, Marine Corps (1109)					
Base Year = 2009					
Fiscal Year	Inflation Rate %	Raw Index	Weighted Index	Budget Year Index	Budget Year Inflation Rate %
2004	2.00%	0.8839	0.9150	0.8991	3.04%
2005	2.80%	0.9087	0.9411	0.9248	2.86%
2006	3.10%	0.9368	0.9708	0.9540	3.16%
2007	2.70%	0.9621	0.9897	0.9725	1.94%
2008	2.40%	0.9852	1.0047	0.9873	1.52%
2009	1.50%	1.0000	1.0176	1.0000	1.28%
2010	1.00%	1.0100	1.0326	1.0147	1.47%
2011	1.40%	1.0241	1.0500	1.0318	1.69%
2012	1.70%	1.0416	1.0687	1.0502	1.78%
2013	1.80%	1.0603	1.0880	1.0691	1.80%
2014	1.80%	1.0794	1.1076	1.0884	1.80%
2015	1.80%	1.0988	1.1275	1.1079	1.80%
2016	1.80%	1.1186	1.1478	1.1279	1.80%
2017	1.80%	1.1387	1.1684	1.1482	1.80%
2018	1.80%	1.1592	1.1895	1.1689	1.80%

Table E-2 shows the inflation rates and raw indices used for the lease alternative and are based on the O&MMC = Operations & Maintenance, Marine Corps (1106) appropriation category with a base year of 2009:

Table E-2: Inflation rates/Raw Indices, Base Year 2009, O&MMC Appropriation Category

O&MMC (Purchases) = Operations & Maintenance, Marine Corps (1106)					
Base Year = 2009					
Fiscal Year	Inflation Rate %	Raw Index	Weighted Index	Budget Year Index	Budget Year Inflation Rate %
2004	2.00%	0.8839	0.8981	0.8914	2.31%
2005	2.80%	0.9087	0.9316	0.9246	3.72%
2006	3.10%	0.9368	0.9535	0.9464	2.36%
2007	2.70%	0.9621	0.9765	0.9692	2.41%
2008	2.40%	0.9852	0.9949	0.9875	1.89%
2009	1.50%	1.0000	1.0075	1.0000	1.27%
2010	1.00%	1.0100	1.0200	1.0124	1.24%
2011	1.40%	1.0241	1.0361	1.0283	1.57%
2012	1.70%	1.0416	1.0542	1.0464	1.75%
2013	1.80%	1.0603	1.0732	1.0652	1.80%
2014	1.80%	1.0794	1.0925	1.0844	1.80%
2015	1.80%	1.0988	1.1122	1.1039	1.80%
2016	1.80%	1.1186	1.1322	1.1238	1.80%
2017	1.80%	1.1387	1.1526	1.1440	1.80%
2018	1.80%	1.1592	1.1733	1.1646	1.80%

APPENDIX F: INCREMENTAL COST CALCULATIONS

The incremental costs associated with certain types of pickup trucks and minivans used in the calculations are based on weighted averages. Table F-1 shows the incremental costs for both pickup trucks and minivans.

Table F-1: Incremental Costs for both Pickup Trucks and Minivans

Pickup Trucks - 2004

Ratio of Incremental Costs		
Inc Costs	Vehicles	WA
\$0	1	5.00%
\$3,081	19	95.00%
\$7,796	0	<u>0.00%</u>
	20	100%
WA Inc. Cost =		\$2,927

Pickup Trucks - 2005

Ratio of Incremental Costs		
Inc Costs	Vehicles	WA
\$768	2	7.14%
\$823	1	3.57%
\$1,616	<u>25</u>	<u>89.29%</u>
	28	100%
WA Inc. Cost =		\$1,527

Pickup Trucks - 2006

Ratio of Incremental Costs		
Inc Costs	Vehicles	WA
\$0	9	21.43%
\$1,098	1	2.38%
\$1,641	3	7.14%
\$1,962	<u>29</u>	<u>69.05%</u>
	42	100%
WA Inc. Cost =		\$1,498

Pickup Trucks - 2007

Ratio of Incremental Costs		
Inc Costs	Vehicles	WA
\$0	48	60.76%
\$3,043	19	24.05%
\$3,687	<u>12</u>	<u>15.19%</u>
	79	100%
WA Inc. Cost =		\$1,292

Pickup Trucks - 2008

Ratio of Incremental Costs		
Inc Costs	Vehicles	WA
\$0	2	4.08%
\$723	4	8.16%
\$1,608	11	22.45%
\$2,252	<u>32</u>	<u>65.31%</u>
	49	100%
WA Inc. Cost =		\$1,891

Pickup Trucks - 2009

Ratio of Incremental Costs		
Inc Costs	Vehicles	WA
\$0	40	50.63%
\$505	2	2.53%
\$1,232	36	45.57%
\$1,357	<u>1</u>	<u>1.27%</u>
	79	100.00%
WA Inc. Cost =		\$591

Minivans - 2004

Ratio of Incremental Costs		
Inc Costs	Vehicles	WA
\$2,020	<u>19</u>	100.00%
	19	100.00%
WA Inc. Cost =	\$2,020	

Minivans - 2005

Ratio of Incremental Costs		
Inc Costs	Vehicles	WA
\$0	34	56.67%
\$606	<u>26</u>	43.33%
	60	100.00%
WA Inc. Cost =	\$263	

Minivans - 2006

Ratio of Incremental Costs		
Inc Costs	Vehicles	WA
\$0	32	94.12%
\$517	<u>2</u>	5.88%
	34	100.00%
WA Inc. Cost =	\$30	

Minivans - 2007

Ratio of Incremental Costs		
Inc Costs	Vehicles	WA
\$0	<u>132</u>	100.00%
	132	100.00%
WA Inc. Cost =	\$0	

Minivans - 2008

Ratio of Incremental Costs		
Inc Costs	Vehicles	WA
\$0	<u>99</u>	100.00%
	99	100.00%
WA Inc. Cost =	\$0	

Minivans - 2009

Ratio of Incremental Costs		
Inc Costs	Vehicles	WA
\$0	<u>144</u>	100.00%
	144	100.00%
WA Inc. Cost =	\$0	

APPENDIX G: MONTHLY LEASE RATE CALCULATIONS

The monthly lease rates associated with certain types of Pickup trucks and Minivans used in the calculations are based on weighted averages. Table G-1 shows the monthly lease rates for both pickup trucks and minivans.

Table G-1: Monthly Lease Rates for both Pickup Trucks and Minivans

Pickup Trucks - 2004

Ratio of Vehicles by SIN and Equip Code				
Lease Rates	SIN	Equip Code	Vehicles	WA
\$197	41	4250	19	95.00%
\$202	41c	4251	<u>1</u>	<u>5.00%</u>
			20	100.00%
WA Lease Rate =			\$197	

Pickup Trucks - 2005

Ratio of Vehicles by SIN and Equip Code				
Lease Rates	SIN	Equip Code	Vehicles	WA
\$202	41	4250	25	89.29%
\$207	41c	4251	<u>3</u>	<u>10.71%</u>
			28	100.00%
WA Lease Rate =			\$203	

Pickup Trucks - 2006

Ratio of Vehicles by SIN and Equip Code				
Lease Rates	SIN	Equip Code	Vehicles	WA
\$202	41	4250	36	85.71%
\$207	41c	4251	1	2.38%
\$226	50	4252	3	7.14%
\$226	51	4252	<u>2</u>	<u>4.76%</u>
			42	100.00%
WA Lease Rate =			\$205	

Pickup Trucks - 2007

Ratio of Vehicles by SIN and Equip Code				
Lease Rates	SIN	Equip Code	Vehicles	WA
\$202	41	4250	31	39.24%
\$207	41c	4251	45	56.96%
\$226	51	4252	<u>3</u>	<u>3.80%</u>
			79	100.00%
WA Lease Rate =			\$206	

Pickup Trucks - 2008

Ratio of Vehicles by SIN and Equip Code				
Lease Rates	SIN	Equip Code	Vehicles	WA
\$202	41	4250	43	87.76%
\$207	41c	4251	2	4.08%
\$226	50	4252	1	2.04%
\$226	51	4252	<u>3</u>	<u>6.12%</u>
			49	100.00%
WA Lease Rate =			\$204	

Pickup Trucks - 2009

Ratio of Vehicles by SIN and Equip Code				
Lease Rates	SIN	Equip Code	Vehicles	WA
\$206	41	4250	36	45.57%
\$211	41c	4251	33	41.77%
\$271	41d	4271	1	1.27%
\$231	50	4252	2	2.53%
\$231	51	4252	<u>7</u>	<u>8.86%</u>
			79	100.00%
WA Lease Rate =			\$212	

Minivans - 2004

Ratio of Vehicles by SIN and Equip Code				
Lease Rates	SIN	Equip Code	Vehicles	WA
\$205	20	4115	2	10.53%
\$190	20b	4116	<u>17</u>	89.47%
			19	100.00%
WA Lease Rate =			\$192	

Minivans - 2005

Ratio of Vehicles by SIN and Equip Code				
Lease Rates	SIN	Equip Code	Vehicles	WA
\$210	20	4115	34	56.67%
\$195	20b	4116	<u>26</u>	43.33%
			60	100.00%
WA Lease Rate =				\$204

Minivans - 2006

Ratio of Vehicles by SIN and Equip Code				
Lease Rates	SIN	Equip Code	Vehicles	WA
\$210	20	4115	32	94.12%
\$195	20b	4116	<u>2</u>	5.88%
			34	100.00%
WA Lease Rate =				\$209

Minivans - 2007

Ratio of Vehicles by SIN and Equip Code				
Lease Rates	SIN	Equip Code	Vehicles	WA
\$210	20	4115	110	83.33%
\$195	20b	4116	<u>22</u>	16.67%
			132	100.00%
WA Lease Rate =				\$208

Minivans - 2008

Ratio of Vehicles by SIN and Equip Code				
Lease Rates	SIN	Equip Code	Vehicles	WA
\$210	20	4115	78	78.79%
\$195	20b	4116	<u>21</u>	21.21%
			99	100.00%
WA Lease Rate =				\$207

Minivans - 2009

Ratio of Vehicles by SIN and Equip Code				
Lease Rates	SIN	Equip Code	Vehicles	WA
\$215	20	4115	<u>144</u>	100.00%
			144	100.00%
WA Lease Rate =				\$215

APPENDIX H: VEHICLE PURCHASE PRICES

The purchase prices associated with certain types of Pickup trucks and Minivans used in the calculations are based on weighted averages. Table H-1 shows the purchase prices for both pickup trucks.

Table G-1: Purchase Prices for Pickup Trucks

Pickup Trucks—2004

Ratio of Vehicles by SIN and Equip Code					
Purchase Price	Incremental Cost	SIN	Equip Code	Vehicles	WA
\$10,287	\$400	41	4250	19	95.00%
\$14,628	\$58	41c	4251	1	5.00%
				20	100.00%
WA Purchase Price =				\$10,504	
WA Incremental Cost =				\$383	

Pickup Trucks—2005

Ratio of Vehicles by SIN and Equip Code					
Purchase Price	Incremental Cost	SIN	Equip Code	Vehicles	WA
\$11,452	\$1,600	41	4250	25	89.29%
\$14,278	\$760	41c.11ga	4251	2	7.14%
\$14,333	\$815	41c.11da	4252	1	3.57%
				28	100.00%
WA Purchase Price =				\$11,245	
WA Incremental Cost =				\$1,483	

Pickup Trucks—2006

Ratio of Vehicles by SIN and Equip Code					
Purchase Price	Incremental Cost	SIN	Equip Code	Vehicles	WA
\$9,905	\$275	41	4250	36	85.71%
\$13,897	\$275	41c	4251	1	2.38%
\$18,472	\$0	50	4252	3	7.14%
\$20,165	\$0	51	4252	2	4.76%
				42	100.00%
WA Purchase Price =				\$11,101	
WA Incremental Cost =				\$242	

Pickup Trucks—2007

Ratio of Vehicles by SIN and Equip Code					
Purchase Price	Incremental Cost	SIN	Equip Code	Vehicles	WA
\$14,200	\$3,650	41	4250	31	39.24%
\$14,900	-\$100	41c	4251	45	56.96%
\$20,837	\$0	51	4252	3	3.80%
				79	100.00%
WA Purchase Price =				\$14,851	
WA Incremental Cost =				\$1,375	

Pickup Trucks—2008

Ratio of Vehicles by SIN and Equip Code					
Purchase Price	Incremental Cost	SIN	Equip Code	Vehicles	WA
\$14,800	\$2,230	41	4250	43	87.76%
\$15,900	\$200	41c	4251	2	4.08%
\$20,796	\$1,432	50	4252	1	2.04%
\$21,553	\$716	51	4252	3	6.12%
				49	100.00%
WA Purchase Price =				\$15,381	
WA Incremental Cost =				\$2,038	

Pickup Trucks—2009

Ratio of Vehicles by SIN and Equip Code					
Purchase Price	Incremental Cost	SIN	Equip Code	Vehicles	WA
\$13,827	\$1,220	41	4250	36	45.57%
\$16,400	\$0	41c	4251	33	41.77%
\$16,800	\$500	41d	4271	1	1.27%
\$19,300	\$500	50	4252	2	2.53%
\$21,922	\$0	51	4252	7	8.86%
				79	100.00%
WA Purchase Price =				\$15,795	
WA Incremental Cost =				\$575	

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APPENDIX I: SENSITIVITY ANALYSIS/DATA TABLES

The values reflected in tables I-1 thru I-15 are positive dollar values. These values represent the costs associated with each alternative. To compare the results, we marked the “Net purchase” column to show the bottom-line analysis of leasing versus purchasing. Negative values in this column represent a loss in overall value, or a higher cost for purchasing vehicles than for leasing them. The point at which this value becomes positive is when purchasing vehicles becomes the more cost-effective approach to acquiring vehicles.

Table I-1. Compact Sedans: Sensitivity Analysis #1

Question: Given changes in depreciation, what are the corresponding changes in NPV between lease and purchase?												
Findings: Given the OMB's current (2009) discount rate of 2.3%, if a vehicle depreciates by less than 36%, then purchasing is the preferred alternative. If depreciation is more than 36%, then the vehicle will lose too much of its value to make purchasing worthwhile—thus, leasing is the preferred alternative.												
	Change in NPV	Depreciation Factor as a Percentage of Purchase Price										
		32.0%	33.0%	34.0%	35.0%	36.0%	37.0%	38.0%	39.0%	40.0%	41.0%	42.0%
Lease	\$8,495,698	\$8,495,698	\$8,495,698	\$8,495,698	\$8,495,698	\$8,495,698	\$8,495,698	\$8,495,698	\$8,495,698	\$8,495,698	\$8,495,698	\$8,495,698
Purchase	\$7,075,103	\$8,029,655	\$8,145,677	\$8,257,311	\$8,364,768	\$8,468,249	\$8,567,950	\$8,664,057	\$8,756,749	\$8,846,197	\$8,932,565	\$9,016,011
Net Purchase	\$1,420,594	\$466,043	\$350,021	\$238,387	\$130,930	\$27,448	(\$72,253)	(\$168,359)	(\$261,051)	(\$350,499)	(\$436,867)	(\$520,313)

Table I-2. Compact Sedans: Sensitivity Analysis #2

Question: Given changes in depreciation and the discount rate, what are the corresponding changes in NPV between lease and purchase?												
Findings: As a general finding, as the discount rate increases, the salvage value of a vehicle loses its effect. For example, when the discount rate is 0.0%, the depreciation can be as much as 40% for purchasing to be the preferred alternative. However, as the discount rate increases, the associated salvage value (or depreciation) decreases to as little as 27% (when the discount rate equals 7.0%) in order for purchasing to remain the preferred alternative.												
Net Purchase	Discount Rate	Depreciation Factor as a Percentage of Purchase Price										
		\$1,420,594	27.0%	29.0%	31.0%	33.0%	35.0%	37.0%	39.0%	41.0%	43.0%	45.0%
Real Discount Rate	0.0%	\$1,717,84	\$1,400,02	\$1,106,60	\$835,359	\$584,241	\$351,357	\$134,960	(\$66,558)	(\$254,671)	(\$430,730)	(\$595,972)
	0.1%	\$1,689,94	\$1,374,03	\$1,082,36	\$812,739	\$563,122	\$331,630	\$116,527	(\$83,786)	(\$270,774)	(\$445,781)	(\$610,034)
	0.2%	\$1,662,23	\$1,348,20	\$1,058,27	\$790,264	\$542,138	\$312,029	\$98,210	(\$100,906)	(\$286,777)	(\$460,739)	(\$624,011)
	0.3%	\$1,634,69	\$1,322,54	\$1,034,34	\$767,934	\$521,289	\$292,552	\$80,010	(\$117,918)	(\$302,680)	(\$475,604)	(\$637,902)
	0.4%	\$1,607,34	\$1,297,05	\$1,010,57	\$745,747	\$500,572	\$273,199	\$61,924	(\$134,824)	(\$318,485)	(\$490,378)	(\$651,708)
	0.5%	\$1,580,16	\$1,271,72	\$986,951	\$723,702	\$479,988	\$253,969	\$43,951	(\$151,625)	(\$334,192)	(\$505,061)	(\$665,431)
	0.6%	\$1,553,16	\$1,246,55	\$963,481	\$701,799	\$459,534	\$234,860	\$26,092	(\$168,321)	(\$349,801)	(\$519,654)	(\$679,069)
	0.7%	\$1,526,34	\$1,221,55	\$940,163	\$680,035	\$439,211	\$215,872	\$8,345	(\$184,912)	(\$365,314)	(\$534,158)	(\$692,625)
	0.8%	\$1,499,69	\$1,196,71	\$916,994	\$658,411	\$419,016	\$197,004	(\$9,291)	(\$201,401)	(\$380,732)	(\$548,572)	(\$706,099)
	0.9%	\$1,473,21	\$1,172,03	\$893,974	\$636,925	\$398,950	\$178,255	(\$26,817)	(\$217,787)	(\$396,054)	(\$562,899)	(\$719,492)
	1.0%	\$1,446,91	\$1,147,51	\$871,101	\$615,576	\$379,011	\$159,623	(\$44,233)	(\$234,071)	(\$411,282)	(\$577,138)	(\$732,803)
	1.1%	\$1,420,77	\$1,123,15	\$848,375	\$594,362	\$359,198	\$141,109	(\$61,540)	(\$250,255)	(\$426,417)	(\$591,291)	(\$746,034)
	1.2%	\$1,394,81	\$1,098,95	\$825,794	\$573,283	\$339,510	\$122,711	(\$78,740)	(\$266,338)	(\$441,458)	(\$605,358)	(\$759,185)
	1.3%	\$1,369,01	\$1,074,89	\$803,357	\$552,338	\$319,946	\$104,428	(\$95,832)	(\$282,323)	(\$456,408)	(\$619,339)	(\$772,258)
	1.4%	\$1,343,38	\$1,051,00	\$781,063	\$531,526	\$300,505	\$86,260	(\$112,819)	(\$298,208)	(\$471,266)	(\$633,235)	(\$785,252)
	1.5%	\$1,317,91	\$1,027,25	\$758,911	\$510,845	\$281,187	\$68,204	(\$129,700)	(\$313,996)	(\$486,033)	(\$647,048)	(\$798,167)
	1.6%	\$1,292,60	\$1,003,66	\$736,899	\$490,295	\$261,990	\$50,262	(\$146,477)	(\$329,687)	(\$500,711)	(\$660,776)	(\$811,006)
	1.7%	\$1,267,46	\$980,224	\$715,028	\$469,875	\$242,913	\$32,431	(\$163,149)	(\$345,282)	(\$515,299)	(\$674,422)	(\$823,768)
	1.8%	\$1,242,48	\$956,932	\$693,295	\$449,583	\$223,956	\$14,712	(\$179,719)	(\$360,781)	(\$529,798)	(\$687,986)	(\$836,454)
	1.9%	\$1,217,66	\$933,788	\$671,699	\$429,419	\$205,117	(\$2,898)	(\$196,187)	(\$376,185)	(\$544,210)	(\$701,468)	(\$849,064)
	2.0%	\$1,193,00	\$910,791	\$650,240	\$409,382	\$186,396	(\$20,398)	(\$212,553)	(\$391,495)	(\$558,534)	(\$714,870)	(\$861,599)
	2.1%	\$1,168,49	\$887,940	\$628,917	\$389,470	\$167,792	(\$37,790)	(\$228,819)	(\$406,711)	(\$572,771)	(\$728,191)	(\$874,060)
	2.2%	\$1,144,14	\$865,234	\$607,728	\$369,684	\$149,304	(\$55,075)	(\$244,984)	(\$421,835)	(\$586,922)	(\$741,432)	(\$886,447)
	2.3%	\$1,119,95	\$842,672	\$586,672	\$350,021	\$130,930	(\$72,253)	(\$261,051)	(\$436,867)	(\$600,988)	(\$754,594)	(\$898,760)
	2.4%	\$1,095,91	\$820,253	\$565,749	\$330,481	\$112,671	(\$89,324)	(\$277,019)	(\$451,808)	(\$614,970)	(\$767,677)	(\$911,001)
	2.5%	\$1,072,02	\$797,975	\$544,957	\$311,063	\$94,525	(\$106,291)	(\$292,890)	(\$466,658)	(\$628,867)	(\$780,682)	(\$923,169)
	2.6%	\$1,048,28	\$775,837	\$524,296	\$291,766	\$76,491	(\$123,153)	(\$308,663)	(\$481,417)	(\$642,680)	(\$793,611)	(\$935,266)
	2.7%	\$1,024,70	\$753,839	\$503,763	\$272,589	\$58,569	(\$139,912)	(\$324,341)	(\$496,088)	(\$656,411)	(\$806,462)	(\$947,292)
	2.8%	\$1,001,26	\$731,979	\$483,360	\$253,531	\$40,757	(\$156,568)	(\$339,923)	(\$510,670)	(\$670,060)	(\$819,237)	(\$959,247)
	2.9%	\$977,976	\$710,257	\$463,084	\$234,592	\$23,055	(\$173,122)	(\$355,410)	(\$525,165)	(\$683,627)	(\$831,936)	(\$971,132)
	3.0%	\$954,835	\$688,671	\$442,934	\$215,770	\$5,463	(\$189,575)	(\$370,804)	(\$539,572)	(\$697,113)	(\$844,560)	(\$982,947)
	3.1%	\$931,838	\$667,220	\$422,909	\$197,064	(\$12,022)	(\$205,927)	(\$386,104)	(\$553,892)	(\$710,519)	(\$857,110)	(\$994,694)

3.2%	\$908,987	\$645,903	\$403,010	\$178,475	(\$29,399)	(\$222,179)	(\$401,312)	(\$568,126)	(\$723,845)	(\$869,586)	(\$1,006,371)
3.3%	\$886,279	\$624,720	\$383,234	\$159,999	(\$46,670)	(\$238,333)	(\$416,427)	(\$582,275)	(\$737,092)	(\$881,988)	(\$1,017,981)
3.4%	\$863,714	\$603,668	\$363,580	\$141,638	(\$63,835)	(\$254,388)	(\$431,452)	(\$596,340)	(\$750,260)	(\$894,318)	(\$1,029,523)
3.5%	\$841,290	\$582,748	\$344,049	\$123,390	(\$80,894)	(\$270,346)	(\$446,385)	(\$610,320)	(\$763,350)	(\$906,575)	(\$1,040,999)
3.6%	\$819,006	\$561,958	\$324,638	\$105,254	(\$97,850)	(\$286,207)	(\$461,229)	(\$624,217)	(\$776,363)	(\$918,760)	(\$1,052,407)
3.7%	\$796,862	\$541,298	\$305,347	\$87,230	(\$114,702)	(\$301,972)	(\$475,984)	(\$638,031)	(\$789,299)	(\$930,874)	(\$1,063,750)
3.8%	\$774,856	\$520,765	\$286,175	\$69,316	(\$131,452)	(\$317,642)	(\$490,651)	(\$651,763)	(\$802,158)	(\$942,917)	(\$1,075,027)
3.9%	\$752,987	\$500,360	\$267,121	\$51,511	(\$148,100)	(\$333,217)	(\$505,229)	(\$665,413)	(\$814,942)	(\$954,890)	(\$1,086,239)
4.0%	\$731,254	\$480,081	\$248,185	\$33,816	(\$164,646)	(\$348,698)	(\$519,720)	(\$678,983)	(\$827,651)	(\$966,794)	(\$1,097,386)
4.1%	\$709,656	\$459,928	\$229,365	\$16,228	(\$181,093)	(\$364,086)	(\$534,125)	(\$692,471)	(\$840,285)	(\$978,628)	(\$1,108,469)
4.2%	\$688,193	\$439,899	\$210,660	(\$1,252)	(\$197,440)	(\$379,382)	(\$548,444)	(\$705,881)	(\$852,845)	(\$990,393)	(\$1,119,489)
4.3%	\$666,862	\$419,993	\$192,071	(\$18,626)	(\$213,687)	(\$394,586)	(\$562,677)	(\$719,211)	(\$865,332)	(\$1,002,090)	(\$1,130,445)
4.4%	\$645,664	\$400,211	\$173,594	(\$35,894)	(\$229,837)	(\$409,698)	(\$576,826)	(\$732,462)	(\$877,745)	(\$1,013,720)	(\$1,141,339)
4.5%	\$624,597	\$380,549	\$155,231	(\$53,057)	(\$245,889)	(\$424,720)	(\$590,891)	(\$745,635)	(\$890,086)	(\$1,025,282)	(\$1,152,170)
4.6%	\$603,660	\$361,009	\$136,980	(\$70,116)	(\$261,845)	(\$439,653)	(\$604,872)	(\$758,731)	(\$902,356)	(\$1,036,778)	(\$1,162,939)
4.7%	\$582,852	\$341,588	\$118,841	(\$87,072)	(\$277,705)	(\$454,496)	(\$618,771)	(\$771,750)	(\$914,554)	(\$1,048,207)	(\$1,173,648)
4.8%	\$562,173	\$322,287	\$100,811	(\$103,925)	(\$293,469)	(\$469,250)	(\$632,587)	(\$784,693)	(\$926,681)	(\$1,059,571)	(\$1,184,295)
4.9%	\$541,621	\$303,103	\$82,892	(\$120,677)	(\$309,139)	(\$483,917)	(\$646,322)	(\$797,560)	(\$938,737)	(\$1,070,869)	(\$1,194,882)
5.0%	\$521,195	\$284,037	\$65,081	(\$137,327)	(\$324,715)	(\$498,497)	(\$659,976)	(\$810,351)	(\$950,724)	(\$1,082,103)	(\$1,205,408)
5.1%	\$500,894	\$265,087	\$47,378	(\$153,877)	(\$340,198)	(\$512,990)	(\$673,550)	(\$823,068)	(\$962,642)	(\$1,093,272)	(\$1,215,875)
5.2%	\$480,718	\$246,253	\$29,782	(\$170,328)	(\$355,588)	(\$527,397)	(\$687,043)	(\$835,711)	(\$974,491)	(\$1,104,378)	(\$1,226,283)
5.3%	\$460,665	\$227,533	\$12,293	(\$186,679)	(\$370,887)	(\$541,719)	(\$700,458)	(\$848,281)	(\$986,271)	(\$1,115,420)	(\$1,236,632)
5.4%	\$440,735	\$208,927	(\$5,091)	(\$202,933)	(\$386,094)	(\$555,957)	(\$713,793)	(\$860,777)	(\$997,984)	(\$1,126,399)	(\$1,246,923)
5.5%	\$420,927	\$190,434	(\$22,369)	(\$219,089)	(\$401,211)	(\$570,110)	(\$727,051)	(\$873,201)	(\$1,009,629)	(\$1,137,316)	(\$1,257,156)
5.6%	\$401,240	\$172,053	(\$39,544)	(\$235,149)	(\$416,239)	(\$584,180)	(\$740,231)	(\$885,553)	(\$1,021,207)	(\$1,148,170)	(\$1,267,331)
5.7%	\$381,672	\$153,784	(\$56,615)	(\$251,112)	(\$431,177)	(\$598,167)	(\$753,335)	(\$897,833)	(\$1,032,720)	(\$1,158,963)	(\$1,277,450)
5.8%	\$362,224	\$135,624	(\$73,584)	(\$266,981)	(\$446,026)	(\$612,072)	(\$766,362)	(\$910,042)	(\$1,044,166)	(\$1,169,696)	(\$1,287,511)
5.9%	\$342,893	\$117,575	(\$90,451)	(\$282,755)	(\$460,788)	(\$625,895)	(\$779,313)	(\$922,182)	(\$1,055,547)	(\$1,180,367)	(\$1,297,517)
6.0%	\$323,680	\$99,634	(\$107,217)	(\$298,435)	(\$475,463)	(\$639,637)	(\$792,189)	(\$934,251)	(\$1,066,863)	(\$1,190,978)	(\$1,307,466)
6.1%	\$304,584	\$81,802	(\$123,883)	(\$314,021)	(\$490,051)	(\$653,299)	(\$804,990)	(\$946,250)	(\$1,078,114)	(\$1,201,529)	(\$1,317,361)
6.2%	\$285,603	\$64,076	(\$140,449)	(\$329,516)	(\$504,553)	(\$666,881)	(\$817,717)	(\$958,181)	(\$1,089,302)	(\$1,212,021)	(\$1,327,200)
6.3%	\$266,736	\$46,457	(\$156,916)	(\$344,918)	(\$518,970)	(\$680,384)	(\$830,370)	(\$970,043)	(\$1,100,426)	(\$1,222,454)	(\$1,336,984)
6.4%	\$247,984	\$28,944	(\$173,285)	(\$360,229)	(\$533,302)	(\$693,808)	(\$842,951)	(\$981,838)	(\$1,111,487)	(\$1,232,829)	(\$1,346,714)
6.5%	\$229,345	\$11,536	(\$189,556)	(\$375,450)	(\$547,550)	(\$707,154)	(\$855,458)	(\$993,565)	(\$1,122,485)	(\$1,243,145)	(\$1,356,390)
6.6%	\$210,817	(\$5,768)	(\$205,731)	(\$390,581)	(\$561,715)	(\$720,422)	(\$867,894)	(\$1,005,225)	(\$1,133,421)	(\$1,253,404)	(\$1,366,013)
6.7%	\$192,402	(\$22,969)	(\$221,810)	(\$405,623)	(\$575,796)	(\$733,613)	(\$880,258)	(\$1,016,819)	(\$1,144,296)	(\$1,263,605)	(\$1,375,583)
6.8%	\$174,097	(\$40,067)	(\$237,794)	(\$420,576)	(\$589,796)	(\$746,728)	(\$892,551)	(\$1,028,346)	(\$1,155,109)	(\$1,273,749)	(\$1,385,099)
6.9%	\$155,901	(\$57,063)	(\$253,683)	(\$435,442)	(\$603,714)	(\$759,767)	(\$904,773)	(\$1,039,808)	(\$1,165,861)	(\$1,283,837)	(\$1,394,564)
7.0%	\$137,815	(\$73,958)	(\$269,478)	(\$450,220)	(\$617,551)	(\$772,731)	(\$916,926)	(\$1,051,205)	(\$1,176,553)	(\$1,293,869)	(\$1,403,976)

Table I-3. Compact Sedans: Sensitivity Analysis #3

<p>Question: Given changes in incremental costs of both leased and purchased vehicles (both have differing values), what are the corresponding changes in NPV between lease and purchase?</p>												
<p>Findings: When the incremental cost of leasing and purchasing are equal, purchasing is always the preferred alternative. Holding the incremental cost of leasing at \$0, the incremental cost of purchasing can increase to just over \$1,000 for purchasing to remain the preferred alternative. Also observed is that for every \$250 increase in the incremental cost of leasing, the incremental cost of purchasing can increase by \$500 for purchasing to still remain the preferred alternative.</p>												
Incremental Cost—Lease												
Net Purchase	\$1,420,594	\$0	\$250	\$500	\$750	\$1,000	\$1,250	\$1,500	\$1,750	\$2,000	\$2,250	\$2,500
Incremental Cost—Purchase	\$0	\$576,562	\$780,235	\$983,908	\$1,187,580	\$1,391,253	\$1,594,926	\$1,798,598	\$2,002,271	\$2,205,944	\$2,409,616	\$2,613,289
	\$250	\$451,320	\$654,993	\$858,666	\$1,062,338	\$1,266,011	\$1,469,684	\$1,673,356	\$1,877,029	\$2,080,702	\$2,284,374	\$2,488,047
	\$500	\$326,078	\$529,751	\$733,423	\$937,096	\$1,140,769	\$1,344,441	\$1,548,114	\$1,751,787	\$1,955,459	\$2,159,132	\$2,362,805
	\$750	\$200,836	\$404,509	\$608,181	\$811,854	\$1,015,527	\$1,219,199	\$1,422,872	\$1,626,545	\$1,830,217	\$2,033,890	\$2,237,562
	\$1,000	\$75,594	\$279,266	\$482,939	\$686,612	\$890,284	\$1,093,957	\$1,297,630	\$1,501,302	\$1,704,975	\$1,908,648	\$2,112,320
	\$1,250	(\$49,648)	\$154,024	\$357,697	\$561,370	\$765,042	\$968,715	\$1,172,387	\$1,376,060	\$1,579,733	\$1,783,405	\$1,987,078
	\$1,500	(\$174,891)	\$28,782	\$232,455	\$436,127	\$639,800	\$843,473	\$1,047,145	\$1,250,818	\$1,454,491	\$1,658,163	\$1,861,836
	\$1,750	(\$300,133)	(\$96,460)	\$107,213	\$310,885	\$514,558	\$718,230	\$921,903	\$1,125,576	\$1,329,248	\$1,532,921	\$1,736,594
	\$2,000	(\$425,375)	(\$221,702)	(\$18,030)	\$185,643	\$389,316	\$592,988	\$796,661	\$1,000,334	\$1,204,006	\$1,407,679	\$1,611,352
	\$2,250	(\$550,617)	(\$346,945)	(\$143,272)	\$60,401	\$264,073	\$467,746	\$671,419	\$875,091	\$1,078,764	\$1,282,437	\$1,486,109
	\$2,500	(\$675,859)	(\$472,187)	(\$268,514)	(\$64,841)	\$138,831	\$342,504	\$546,177	\$749,849	\$953,522	\$1,157,195	\$1,360,867
	\$2,750	(\$801,102)	(\$597,429)	(\$393,756)	(\$190,084)	\$13,589	\$217,262	\$420,934	\$624,607	\$828,280	\$1,031,952	\$1,235,625
	\$3,000	(\$926,344)	(\$722,671)	(\$518,998)	(\$315,326)	(\$111,653)	\$92,020	\$295,692	\$499,365	\$703,038	\$906,710	\$1,110,383
	\$3,250	(\$1,051,586)	(\$847,913)	(\$644,241)	(\$440,568)	(\$236,895)	(\$33,223)	\$170,450	\$374,123	\$577,795	\$781,468	\$985,141
	\$3,500	(\$1,176,828)	(\$973,155)	(\$769,483)	(\$565,810)	(\$362,137)	(\$158,465)	\$45,208	\$248,881	\$452,553	\$656,226	\$859,898
	\$3,750	(\$1,302,070)	(\$1,098,398)	(\$894,725)	(\$691,052)	(\$487,380)	(\$283,707)	(\$80,034)	\$123,638	\$327,311	\$530,984	\$734,656
	\$4,000	(\$1,427,312)	(\$1,223,640)	(\$1,019,967)	(\$816,294)	(\$612,622)	(\$408,949)	(\$205,277)	(\$1,604)	\$202,069	\$405,741	\$609,414
	\$4,250	(\$1,552,555)	(\$1,348,882)	(\$1,145,209)	(\$941,537)	(\$737,864)	(\$534,191)	(\$330,519)	(\$126,846)	\$76,827	\$280,499	\$484,172
	\$4,500	(\$1,677,797)	(\$1,474,124)	(\$1,270,452)	(\$1,066,779)	(\$863,106)	(\$659,434)	(\$455,761)	(\$252,088)	(\$48,416)	\$155,257	\$358,930
	\$4,750	(\$1,803,039)	(\$1,599,366)	(\$1,395,694)	(\$1,192,021)	(\$988,348)	(\$784,676)	(\$581,003)	(\$377,330)	(\$173,658)	\$30,015	\$233,688
	\$5,000	(\$1,928,281)	(\$1,724,609)	(\$1,520,936)	(\$1,317,263)	(\$1,113,591)	(\$909,918)	(\$706,245)	(\$502,573)	(\$298,900)	(\$95,227)	\$108,445
	\$5,250	(\$2,053,523)	(\$1,849,851)	(\$1,646,178)	(\$1,442,505)	(\$1,238,833)	(\$1,035,160)	(\$831,487)	(\$627,815)	(\$424,142)	(\$220,469)	(\$16,797)
	\$5,500	(\$2,178,766)	(\$1,975,093)	(\$1,771,420)	(\$1,567,748)	(\$1,364,075)	(\$1,160,402)	(\$956,730)	(\$753,057)	(\$549,384)	(\$345,712)	(\$142,039)
	\$5,750	(\$2,304,008)	(\$2,100,335)	(\$1,896,662)	(\$1,692,990)	(\$1,489,317)	(\$1,285,644)	(\$1,081,972)	(\$878,299)	(\$674,626)	(\$470,954)	(\$267,281)
	\$6,000	(\$2,429,250)	(\$2,225,577)	(\$2,021,905)	(\$1,818,232)	(\$1,614,559)	(\$1,410,887)	(\$1,207,214)	(\$1,003,541)	(\$799,869)	(\$596,196)	(\$392,523)

Table I-4. Compact Sedans: Sensitivity Analysis #4

Question: Given changes in the monthly lease rate and the purchase price, what are the corresponding changes in NPV between lease and purchase?												
Findings: The monthly lease rate can decrease by 25% and the purchase price can decrease by 10% for purchasing to remain the preferred alternative. If the lease rate is fixed at 0.0%, the purchase price can increase by as much as 20% for purchasing to remain the preferred alternative. Conversely, as the purchase price stays the same, the monthly lease rate can decrease by as much as 15%, and purchasing will still remain the preferred alternative.												
		Monthly Lease Rate										
Net Purchase	\$1,420,594	-30%	-25%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Purchase Price	-10%	(\$158,085)	\$222,171	\$602,427	\$982,682	\$1,362,938	\$1,743,194	\$2,123,450	\$2,503,705	\$2,883,961	\$3,264,217	\$3,644,473
	-5%	(\$509,512)	(\$129,257)	\$250,999	\$631,255	\$1,011,511	\$1,391,766	\$1,772,022	\$2,152,278	\$2,532,533	\$2,912,789	\$3,293,045
	0%	(\$860,940)	(\$480,684)	(\$100,428)	\$279,827	\$660,083	\$1,040,339	\$1,420,594	\$1,800,850	\$2,181,106	\$2,561,362	\$2,941,617
	5%	(\$1,212,368)	(\$832,112)	(\$451,856)	(\$71,600)	\$308,655	\$688,911	\$1,069,167	\$1,449,423	\$1,829,678	\$2,209,934	\$2,590,190
	10%	(\$1,563,795)	(\$1,183,539)	(\$803,284)	(\$423,028)	(\$42,772)	\$337,483	\$717,739	\$1,097,995	\$1,478,251	\$1,858,506	\$2,238,762
	15%	(\$1,915,223)	(\$1,534,967)	(\$1,154,711)	(\$774,456)	(\$394,200)	(\$13,944)	\$366,312	\$746,567	\$1,126,823	\$1,507,079	\$1,887,335
	20%	(\$2,266,650)	(\$1,886,395)	(\$1,506,139)	(\$1,125,883)	(\$745,627)	(\$365,372)	\$14,884	\$395,140	\$775,395	\$1,155,651	\$1,535,907
	25%	(\$2,618,078)	(\$2,237,822)	(\$1,857,566)	(\$1,477,311)	(\$1,097,055)	(\$716,799)	(\$336,544)	\$43,712	\$423,968	\$804,224	\$1,184,479
	30%	(\$2,969,506)	(\$2,589,250)	(\$2,208,994)	(\$1,828,738)	(\$1,448,483)	(\$1,068,227)	(\$687,971)	(\$307,715)	\$72,540	\$452,796	\$833,052
	35%	(\$3,320,933)	(\$2,940,677)	(\$2,560,422)	(\$2,180,166)	(\$1,799,910)	(\$1,419,655)	(\$1,039,399)	(\$659,143)	(\$278,887)	\$101,368	\$481,624
	40%	(\$3,672,361)	(\$3,292,105)	(\$2,911,849)	(\$2,531,594)	(\$2,151,338)	(\$1,771,082)	(\$1,390,826)	(\$1,010,571)	(\$630,315)	(\$250,059)	\$130,197

Table I-5. Compact Sedans: Sensitivity Analysis #5

<p>Question: Holding all variables constant, if the Marine Corps wants to either increase or decrease its inventory of AFV compact sedans (based on current fleet size), what is the corresponding increase or decrease in fleet size that will shift the preferred alternative between leasing and purchasing?</p>												
<p>Findings: The USMC is indifferent to a decrease or increase in its compact sedan inventory. As the table shows, the USMC can decrease its inventory by more than 70%, and purchasing would still be the preferred option. Likewise, as the USMC increases its inventory, purchasing remains the preferred alternative as cost savings increase with increases in inventory.</p>												
Change in NPV		Change in Inventory										
		-69.0%	-8.0%	-6.0%	-4.0%	-2.0%	0.0%	2.0%	4.0%	6.0%	8.0%	10.0%
Lease	\$8,495,698	\$2,633,666	\$7,816,042	\$7,985,956	\$8,155,870	\$8,325,784	\$8,495,698	\$8,665,612	\$8,835,526	\$9,005,440	\$9,175,354	\$9,345,268
Purchase	\$7,075,103	\$2,095,817	\$6,497,795	\$6,642,122	\$6,786,449	\$6,930,776	\$7,075,103	\$7,219,431	\$7,363,758	\$7,508,085	\$7,652,412	\$7,796,739
Net Purchase	\$1,420,594	\$537,849	\$1,318,247	\$1,343,834	\$1,369,421	\$1,395,008	\$1,420,594	\$1,446,181	\$1,471,768	\$1,497,355	\$1,522,942	\$1,548,528

Table I-6. Pickup Trucks (4x2): Sensitivity Analysis #1

Question: Given changes in depreciation, what are the corresponding changes in NPV between lease and purchase?												
Findings: Given the OMB's current (2009) discount rate of 2.3%, if a vehicle depreciates by less than 28%, then purchasing is the preferred alternative. If depreciation is more than 28%, then the vehicle will lose too much of its value to make purchasing worthwhile—thus, leasing is the preferred alternative.												
	Change in NPV	Depreciation Factor as a Percentage of Purchase Price										
		25.0%	26.0%	27.0%	28.0%	29.0%	30.0%	31.0%	32.0%	33.0%	34.0%	35.0%
Lease	\$2,467,461	\$2,467,461	\$2,467,461	\$2,467,461	\$2,467,461	\$2,467,461	\$2,467,461	\$2,467,461	\$2,467,461	\$2,467,461	\$2,467,461	\$2,467,461
Purchase	\$2,245,574	\$2,245,574	\$2,305,555	\$2,363,999	\$2,420,948	\$2,476,440	\$2,530,513	\$2,583,204	\$2,634,550	\$2,684,586	\$2,733,347	\$2,780,867
Net Purchase	\$221,887	\$221,887	\$161,907	\$103,462	\$46,513	(\$8,979)	(\$63,051)	(\$115,743)	(\$167,089)	(\$217,125)	(\$265,886)	(\$313,406)

Table I-7. Pickup Trucks (4x2): Sensitivity Analysis #2

Question: Given changes in depreciation and the discount rate, what are the corresponding changes in NPV between lease and purchase?												
		Findings: As a general finding, as the discount rate increases, the salvage value of a vehicle loses its effect. For example, when the discount rate is 0.0%, the depreciation can be as much as 31% for purchasing to be the preferred alternative. However, as the discount rate increases, the associated salvage value (or depreciation) decreases to as little as 25% (discount rate of 6.2%) in order for purchasing to remain the preferred alternative.										
	Discount Rate	Depreciation Factor as a percentage of Purchase Price										
Net Purchase	\$221,887	25.0%	26.0%	27.0%	28.0%	29.0%	30.0%	31.0%	32.0%	33.0%	34.0%	35.0%
Discount Rate	0.0%	\$391,652	\$322,904	\$255,915	\$190,642	\$127,038	\$65,061	\$4,667	(\$54,185)	(\$111,536)	(\$167,425)	(\$221,891)
	0.1%	\$383,547	\$315,209	\$248,621	\$183,738	\$120,515	\$58,908	(\$1,125)	(\$59,625)	(\$116,633)	(\$172,188)	(\$226,328)
	0.2%	\$375,511	\$307,582	\$241,392	\$176,896	\$114,050	\$52,811	(\$6,863)	(\$65,014)	(\$121,681)	(\$176,904)	(\$230,721)
	0.3%	\$367,545	\$300,021	\$234,226	\$170,115	\$107,644	\$46,770	(\$12,548)	(\$70,351)	(\$126,680)	(\$181,574)	(\$235,070)
	0.4%	\$359,647	\$292,526	\$227,123	\$163,394	\$101,296	\$40,785	(\$18,179)	(\$75,638)	(\$131,632)	(\$186,198)	(\$239,375)
	0.5%	\$351,818	\$285,096	\$220,083	\$156,733	\$95,005	\$34,855	(\$23,759)	(\$80,875)	(\$136,535)	(\$190,777)	(\$243,637)
	0.6%	\$344,056	\$277,731	\$213,105	\$150,132	\$88,771	\$28,979	(\$29,286)	(\$86,063)	(\$141,392)	(\$195,310)	(\$247,857)
	0.7%	\$336,361	\$270,430	\$206,188	\$143,590	\$82,593	\$23,156	(\$34,762)	(\$91,202)	(\$146,201)	(\$199,800)	(\$252,033)
	0.8%	\$328,733	\$263,193	\$199,332	\$137,106	\$76,472	\$17,387	(\$40,187)	(\$96,291)	(\$150,965)	(\$204,245)	(\$256,168)
	0.9%	\$321,170	\$256,019	\$192,537	\$130,680	\$70,405	\$11,672	(\$45,561)	(\$101,333)	(\$155,682)	(\$208,646)	(\$260,262)
	1.0%	\$313,672	\$248,908	\$185,802	\$124,311	\$64,394	\$6,008	(\$50,886)	(\$106,327)	(\$160,354)	(\$213,004)	(\$264,314)
	1.1%	\$306,240	\$241,858	\$179,126	\$117,999	\$58,436	\$397	(\$56,160)	(\$111,273)	(\$164,980)	(\$217,319)	(\$268,325)
	1.2%	\$298,871	\$234,870	\$172,509	\$111,744	\$52,533	(\$5,163)	(\$61,386)	(\$116,173)	(\$169,562)	(\$221,591)	(\$272,295)
	1.3%	\$291,565	\$227,943	\$165,950	\$105,544	\$46,683	(\$10,672)	(\$66,563)	(\$121,026)	(\$174,100)	(\$225,821)	(\$276,226)
	1.4%	\$284,323	\$221,076	\$159,449	\$99,400	\$40,886	(\$16,131)	(\$71,691)	(\$125,833)	(\$178,594)	(\$230,010)	(\$280,117)
	1.5%	\$277,143	\$214,270	\$153,006	\$93,310	\$35,142	(\$21,539)	(\$76,772)	(\$130,594)	(\$183,044)	(\$234,157)	(\$283,968)
	1.6%	\$270,025	\$207,522	\$146,619	\$87,275	\$29,450	(\$26,897)	(\$81,805)	(\$135,310)	(\$187,451)	(\$238,263)	(\$287,781)
	1.7%	\$262,969	\$200,833	\$140,289	\$81,294	\$23,809	(\$32,207)	(\$86,791)	(\$139,981)	(\$191,815)	(\$242,328)	(\$291,555)
	1.8%	\$255,973	\$194,203	\$134,014	\$75,366	\$18,219	(\$37,467)	(\$91,730)	(\$144,608)	(\$196,137)	(\$246,353)	(\$295,290)
	1.9%	\$249,037	\$187,630	\$127,795	\$69,492	\$12,680	(\$42,679)	(\$96,623)	(\$149,191)	(\$200,417)	(\$250,338)	(\$298,988)
	2.0%	\$242,161	\$181,114	\$121,631	\$63,669	\$7,191	(\$47,843)	(\$101,471)	(\$153,730)	(\$204,655)	(\$254,283)	(\$302,648)
	2.1%	\$235,345	\$174,656	\$115,521	\$57,899	\$1,752	(\$52,959)	(\$106,273)	(\$158,225)	(\$208,853)	(\$258,190)	(\$306,271)
	2.2%	\$228,587	\$168,253	\$109,465	\$52,181	(\$3,638)	(\$58,029)	(\$111,030)	(\$162,678)	(\$213,009)	(\$262,057)	(\$309,857)
	2.3%	\$221,887	\$161,907	\$103,462	\$46,513	(\$8,979)	(\$63,051)	(\$115,743)	(\$167,089)	(\$217,125)	(\$265,886)	(\$313,406)
	2.4%	\$215,246	\$155,615	\$97,512	\$40,896	(\$14,271)	(\$68,028)	(\$120,411)	(\$171,457)	(\$221,201)	(\$269,677)	(\$316,919)
	2.5%	\$208,661	\$149,379	\$91,615	\$35,330	(\$19,515)	(\$72,958)	(\$125,036)	(\$175,784)	(\$225,237)	(\$273,430)	(\$320,396)
	2.6%	\$202,133	\$143,197	\$85,770	\$29,813	(\$24,712)	(\$77,843)	(\$129,617)	(\$180,069)	(\$229,233)	(\$277,145)	(\$323,837)
	2.7%	\$195,661	\$137,069	\$79,977	\$24,346	(\$29,862)	(\$82,683)	(\$134,155)	(\$184,313)	(\$233,191)	(\$280,824)	(\$327,244)
	2.8%	\$189,245	\$130,994	\$74,234	\$18,927	(\$34,965)	(\$87,479)	(\$138,651)	(\$188,516)	(\$237,110)	(\$284,465)	(\$330,615)
	2.9%	\$182,885	\$124,972	\$68,543	\$13,557	(\$40,021)	(\$92,229)	(\$143,104)	(\$192,680)	(\$240,991)	(\$288,071)	(\$333,952)
	3.0%	\$176,579	\$119,003	\$62,901	\$8,236	(\$45,031)	(\$96,937)	(\$147,515)	(\$196,803)	(\$244,833)	(\$291,640)	(\$337,254)
	3.1%	\$170,328	\$113,086	\$57,310	\$2,961	(\$49,996)	(\$101,600)	(\$151,885)	(\$200,887)	(\$248,638)	(\$295,173)	(\$340,523)
	3.2%	\$164,130	\$107,220	\$51,768	(\$2,265)	(\$54,916)	(\$106,221)	(\$156,214)	(\$204,931)	(\$252,406)	(\$298,671)	(\$343,757)

3.3%	\$157,986	\$101,406	\$46,274	(\$7,446)	(\$59,791)	(\$110,798)	(\$160,502)	(\$208,937)	(\$256,137)	(\$302,133)	(\$346,959)
3.4%	\$151,894	\$95,642	\$40,830	(\$12,579)	(\$64,622)	(\$115,334)	(\$164,750)	(\$212,905)	(\$259,831)	(\$305,561)	(\$350,127)
3.5%	\$145,856	\$89,928	\$35,433	(\$17,667)	(\$69,408)	(\$119,827)	(\$168,958)	(\$216,834)	(\$263,488)	(\$308,954)	(\$353,263)
3.6%	\$139,869	\$84,265	\$30,085	(\$22,709)	(\$74,152)	(\$124,279)	(\$173,125)	(\$220,725)	(\$267,110)	(\$312,313)	(\$356,366)
3.7%	\$133,934	\$78,651	\$24,783	(\$27,706)	(\$78,851)	(\$128,689)	(\$177,254)	(\$224,579)	(\$270,696)	(\$315,638)	(\$359,437)
3.8%	\$128,050	\$73,085	\$19,528	(\$32,657)	(\$83,508)	(\$133,059)	(\$181,344)	(\$228,395)	(\$274,247)	(\$318,930)	(\$362,476)
3.9%	\$122,216	\$67,569	\$14,320	(\$37,565)	(\$88,123)	(\$137,388)	(\$185,394)	(\$232,175)	(\$277,763)	(\$322,188)	(\$365,483)
4.0%	\$116,433	\$62,100	\$9,158	(\$42,428)	(\$92,695)	(\$141,677)	(\$189,407)	(\$235,919)	(\$281,244)	(\$325,414)	(\$368,459)
4.1%	\$110,700	\$56,679	\$4,042	(\$47,248)	(\$97,226)	(\$145,926)	(\$193,382)	(\$239,626)	(\$284,690)	(\$328,606)	(\$371,404)
4.2%	\$105,017	\$51,306	(\$1,029)	(\$52,025)	(\$101,715)	(\$150,136)	(\$197,319)	(\$243,297)	(\$288,103)	(\$331,766)	(\$374,319)
4.3%	\$99,382	\$45,980	(\$6,055)	(\$56,758)	(\$106,164)	(\$154,306)	(\$201,218)	(\$246,933)	(\$291,481)	(\$334,895)	(\$377,202)
4.4%	\$93,796	\$40,700	(\$11,037)	(\$61,449)	(\$110,571)	(\$158,438)	(\$205,081)	(\$250,534)	(\$294,827)	(\$337,991)	(\$380,056)
4.5%	\$88,258	\$35,466	(\$15,974)	(\$66,098)	(\$114,939)	(\$162,531)	(\$208,907)	(\$254,099)	(\$298,139)	(\$341,056)	(\$382,880)
4.6%	\$82,767	\$30,278	(\$20,868)	(\$70,705)	(\$119,266)	(\$166,586)	(\$212,697)	(\$257,630)	(\$301,418)	(\$344,089)	(\$385,674)
4.7%	\$77,325	\$25,135	(\$25,718)	(\$75,270)	(\$123,554)	(\$170,603)	(\$216,450)	(\$261,127)	(\$304,664)	(\$347,092)	(\$388,439)
4.8%	\$71,929	\$20,037	(\$30,526)	(\$79,794)	(\$127,803)	(\$174,583)	(\$220,168)	(\$264,590)	(\$307,878)	(\$350,063)	(\$391,175)
4.9%	\$66,579	\$14,984	(\$35,291)	(\$84,278)	(\$132,012)	(\$178,526)	(\$223,851)	(\$268,019)	(\$311,060)	(\$353,005)	(\$393,881)
5.0%	\$61,276	\$9,975	(\$40,013)	(\$88,721)	(\$136,183)	(\$182,432)	(\$227,499)	(\$271,415)	(\$314,211)	(\$355,916)	(\$396,560)
5.1%	\$56,019	\$5,009	(\$44,694)	(\$93,124)	(\$140,316)	(\$186,301)	(\$231,111)	(\$274,777)	(\$317,330)	(\$358,797)	(\$399,210)
5.2%	\$50,807	\$88	(\$49,333)	(\$97,488)	(\$144,411)	(\$190,135)	(\$234,690)	(\$278,107)	(\$320,417)	(\$361,649)	(\$401,831)
5.3%	\$45,640	(\$4,791)	(\$53,930)	(\$101,812)	(\$148,468)	(\$193,932)	(\$238,234)	(\$281,405)	(\$323,474)	(\$364,472)	(\$404,426)
5.4%	\$40,517	(\$9,627)	(\$58,487)	(\$106,097)	(\$152,489)	(\$197,694)	(\$241,744)	(\$284,670)	(\$326,501)	(\$367,265)	(\$406,992)
5.5%	\$35,439	(\$14,421)	(\$63,004)	(\$110,343)	(\$156,472)	(\$201,421)	(\$245,221)	(\$287,903)	(\$329,496)	(\$370,030)	(\$409,531)
5.6%	\$30,405	(\$19,173)	(\$67,480)	(\$114,551)	(\$160,418)	(\$205,112)	(\$248,664)	(\$291,105)	(\$332,462)	(\$372,766)	(\$412,043)
5.7%	\$25,414	(\$23,883)	(\$71,917)	(\$118,721)	(\$164,329)	(\$208,770)	(\$252,075)	(\$294,275)	(\$335,398)	(\$375,473)	(\$414,529)
5.8%	\$20,466	(\$28,552)	(\$76,314)	(\$122,854)	(\$168,203)	(\$212,392)	(\$255,453)	(\$297,414)	(\$338,305)	(\$378,153)	(\$416,987)
5.9%	\$15,561	(\$33,180)	(\$80,672)	(\$126,949)	(\$172,041)	(\$215,981)	(\$258,798)	(\$300,522)	(\$341,182)	(\$380,805)	(\$419,420)
6.0%	\$10,698	(\$37,767)	(\$84,991)	(\$131,007)	(\$175,845)	(\$219,536)	(\$262,112)	(\$303,600)	(\$344,030)	(\$383,429)	(\$421,826)
6.1%	\$5,878	(\$42,314)	(\$89,272)	(\$135,028)	(\$179,613)	(\$223,058)	(\$265,393)	(\$306,647)	(\$346,849)	(\$386,026)	(\$424,206)
6.2%	\$1,099	(\$46,822)	(\$93,515)	(\$139,012)	(\$183,346)	(\$226,546)	(\$268,643)	(\$309,665)	(\$349,640)	(\$388,596)	(\$426,561)
6.3%	(\$3,639)	(\$51,289)	(\$97,719)	(\$142,961)	(\$187,045)	(\$230,002)	(\$271,862)	(\$312,652)	(\$352,402)	(\$391,140)	(\$428,891)
6.4%	(\$8,336)	(\$55,718)	(\$101,887)	(\$146,874)	(\$190,710)	(\$233,425)	(\$275,049)	(\$315,610)	(\$355,137)	(\$393,656)	(\$431,195)
6.5%	(\$12,992)	(\$60,107)	(\$106,017)	(\$150,751)	(\$194,341)	(\$236,816)	(\$278,206)	(\$318,539)	(\$357,844)	(\$396,146)	(\$433,474)
6.6%	(\$17,607)	(\$64,459)	(\$110,110)	(\$154,593)	(\$197,938)	(\$240,175)	(\$281,333)	(\$321,439)	(\$360,523)	(\$398,611)	(\$435,729)
6.7%	(\$22,183)	(\$68,772)	(\$114,167)	(\$158,401)	(\$201,502)	(\$243,502)	(\$284,429)	(\$324,311)	(\$363,175)	(\$401,049)	(\$437,959)
6.8%	(\$26,719)	(\$73,047)	(\$118,188)	(\$162,173)	(\$205,033)	(\$246,798)	(\$287,495)	(\$327,153)	(\$365,800)	(\$403,461)	(\$440,164)
6.9%	(\$31,216)	(\$77,284)	(\$122,172)	(\$165,912)	(\$208,532)	(\$250,062)	(\$290,532)	(\$329,968)	(\$368,398)	(\$405,849)	(\$442,346)
7.0%	(\$35,674)	(\$81,484)	(\$126,121)	(\$169,616)	(\$211,998)	(\$253,296)	(\$293,539)	(\$332,754)	(\$370,970)	(\$408,211)	(\$444,504)

Table I-8. Pickup Trucks (4x2): Sensitivity Analysis #3

Question: Given changes in incremental costs of both leased and purchased vehicles (both have differing values), what are the corresponding changes in NPV between lease and purchase?												
Findings: When the incremental cost of leasing and purchasing remain the same, leasing is the preferred alternative. However, once the incremental cost to lease increases to \$250, and the and the incremental cost to purchase remains the same, then purchasing becomes the preferred alternative. Additionally, for every \$250 increase over \$500 in the incremental cost to lease, the incremental cost to purchase can increase by \$500, and purchasing will still remain the preferred alternative.												
		Incremental Cost—Lease										
Net Purchase	\$221,887	\$0	\$250	\$500	\$750	\$1,000	\$1,250	\$1,500	\$1,750	\$2,000	\$2,250	\$2,500
Incremental Cost—Purchase	\$0	(\$29,476)	\$39,910	\$109,296	\$178,681	\$248,067	\$317,453	\$386,839	\$456,224	\$525,610	\$594,996	\$664,382
	\$250	(\$66,670)	\$2,716	\$72,102	\$141,488	\$210,873	\$280,259	\$349,645	\$419,031	\$488,416	\$557,802	\$627,188
	\$500	(\$103,863)	(\$34,478)	\$34,908	\$104,294	\$173,680	\$243,065	\$312,451	\$381,837	\$451,223	\$520,608	\$589,994
	\$750	(\$141,057)	(\$71,671)	(\$2,286)	\$67,100	\$136,486	\$205,872	\$275,257	\$344,643	\$414,029	\$483,415	\$552,800
	\$1,000	(\$178,251)	(\$108,865)	(\$39,479)	\$29,906	\$99,292	\$168,678	\$238,064	\$307,449	\$376,835	\$446,221	\$515,607
	\$1,250	(\$215,445)	(\$146,059)	(\$76,673)	(\$7,287)	\$62,098	\$131,484	\$200,870	\$270,256	\$339,641	\$409,027	\$478,413
	\$1,500	(\$252,638)	(\$183,253)	(\$113,867)	(\$44,481)	\$24,905	\$94,290	\$163,676	\$233,062	\$302,448	\$371,833	\$441,219
	\$1,750	(\$289,832)	(\$220,446)	(\$151,061)	(\$81,675)	(\$12,289)	\$57,097	\$126,482	\$195,868	\$265,254	\$334,640	\$404,025
	\$2,000	(\$327,026)	(\$257,640)	(\$188,254)	(\$118,869)	(\$49,483)	\$19,903	\$89,289	\$158,674	\$228,060	\$297,446	\$366,832
	\$2,250	(\$364,220)	(\$294,834)	(\$225,448)	(\$156,062)	(\$86,677)	(\$17,291)	\$52,095	\$121,481	\$190,866	\$260,252	\$329,638
	\$2,500	(\$401,414)	(\$332,028)	(\$262,642)	(\$193,256)	(\$123,870)	(\$54,485)	\$14,901	\$84,287	\$153,673	\$223,058	\$292,444
	\$2,750	(\$438,607)	(\$369,221)	(\$299,836)	(\$230,450)	(\$161,064)	(\$91,678)	(\$22,293)	\$47,093	\$116,479	\$185,865	\$255,250
	\$3,000	(\$475,801)	(\$406,415)	(\$337,029)	(\$267,644)	(\$198,258)	(\$128,872)	(\$59,486)	\$9,899	\$79,285	\$148,671	\$218,057
	\$3,250	(\$512,995)	(\$443,609)	(\$374,223)	(\$304,837)	(\$235,452)	(\$166,066)	(\$96,680)	(\$27,294)	\$42,091	\$111,477	\$180,863
	\$3,500	(\$550,189)	(\$480,803)	(\$411,417)	(\$342,031)	(\$272,645)	(\$203,260)	(\$133,874)	(\$64,488)	\$4,898	\$74,283	\$143,669
	\$3,750	(\$587,382)	(\$517,997)	(\$448,611)	(\$379,225)	(\$309,839)	(\$240,453)	(\$171,068)	(\$101,682)	(\$32,296)	\$37,090	\$106,475
	\$4,000	(\$624,576)	(\$555,190)	(\$485,805)	(\$416,419)	(\$347,033)	(\$277,647)	(\$208,261)	(\$138,876)	(\$69,490)	(\$104)	\$69,282
	\$4,250	(\$661,770)	(\$592,384)	(\$522,998)	(\$453,612)	(\$384,227)	(\$314,841)	(\$245,455)	(\$176,069)	(\$106,684)	(\$37,298)	\$32,088
	\$4,500	(\$698,964)	(\$629,578)	(\$560,192)	(\$490,806)	(\$421,420)	(\$352,035)	(\$282,649)	(\$213,263)	(\$143,877)	(\$74,492)	(\$5,106)
	\$4,750	(\$736,157)	(\$666,772)	(\$597,386)	(\$528,000)	(\$458,614)	(\$389,228)	(\$319,843)	(\$250,457)	(\$181,071)	(\$111,685)	(\$42,300)
	\$5,000	(\$773,351)	(\$703,965)	(\$634,580)	(\$565,194)	(\$495,808)	(\$426,422)	(\$357,036)	(\$287,651)	(\$218,265)	(\$148,879)	(\$79,493)
	\$5,250	(\$810,545)	(\$741,159)	(\$671,773)	(\$602,388)	(\$533,002)	(\$463,616)	(\$394,230)	(\$324,844)	(\$255,459)	(\$186,073)	(\$116,687)
	\$5,500	(\$847,739)	(\$778,353)	(\$708,967)	(\$639,581)	(\$570,196)	(\$500,810)	(\$431,424)	(\$362,038)	(\$292,652)	(\$223,267)	(\$153,881)
	\$5,750	(\$884,932)	(\$815,547)	(\$746,161)	(\$676,775)	(\$607,389)	(\$538,003)	(\$468,618)	(\$399,232)	(\$329,846)	(\$260,460)	(\$191,075)
	\$6,000	(\$922,126)	(\$852,740)	(\$783,355)	(\$713,969)	(\$644,583)	(\$575,197)	(\$505,811)	(\$436,426)	(\$367,040)	(\$297,654)	(\$228,268)

Table I-9. Pickup Trucks (4x2): Sensitivity Analysis #4

Question: Given changes in monthly lease rate and the purchase price, what are the corresponding changes in NPV between lease and purchase?												
Findings: The monthly lease rate can decrease by 20% and the purchase price can decrease by 10% for purchasing to remain the preferred alternative. If the lease rate is fixed at 0.0%, the purchase price can increase by as much as 10% for purchasing to remain the preferred alternative. Conversely, as the purchase price stays the same, the monthly lease rate can decrease by as much as 10%, and purchasing will still remain the preferred alternative.												
		Monthly Lease Rate										
Net Purchase	\$221,887	-30%	-25%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Purchase Price	-10%	(\$185,570)	(\$82,969)	\$19,632	\$122,234	\$224,835	\$327,436	\$430,038	\$532,639	\$635,241	\$737,842	\$840,443
	-5%	(\$289,646)	(\$187,044)	(\$84,443)	\$18,159	\$120,760	\$223,361	\$325,963	\$428,564	\$531,165	\$633,767	\$736,368
	0%	(\$393,721)	(\$291,119)	(\$188,518)	(\$85,917)	\$16,685	\$119,286	\$221,887	\$324,489	\$427,090	\$529,692	\$632,293
	5%	(\$497,796)	(\$395,195)	(\$292,593)	(\$189,992)	(\$87,390)	\$15,211	\$117,812	\$220,414	\$323,015	\$425,616	\$528,218
	10%	(\$601,871)	(\$499,270)	(\$396,668)	(\$294,067)	(\$191,466)	(\$88,864)	(\$13,737)	\$116,338	\$218,940	\$321,541	\$424,143
	15%	(\$705,946)	(\$603,345)	(\$500,744)	(\$398,142)	(\$295,541)	(\$192,939)	(\$90,338)	\$12,263	\$114,865	\$217,466	\$320,067
	20%	(\$810,021)	(\$707,420)	(\$604,819)	(\$502,217)	(\$399,616)	(\$297,015)	(\$194,413)	(\$91,812)	\$10,790	\$113,391	\$215,992
	25%	(\$914,097)	(\$811,495)	(\$708,894)	(\$606,292)	(\$503,691)	(\$401,090)	(\$298,488)	(\$195,887)	(\$93,286)	\$9,316	\$111,917
	30%	(\$1,018,172)	(\$915,570)	(\$812,969)	(\$710,368)	(\$607,766)	(\$505,165)	(\$402,564)	(\$299,962)	(\$197,361)	(\$94,759)	\$7,842
	35%	(\$1,122,247)	(\$1,019,646)	(\$917,044)	(\$814,443)	(\$711,841)	(\$609,240)	(\$506,639)	(\$404,037)	(\$301,436)	(\$198,835)	(\$96,233)
	40%	(\$1,226,322)	(\$1,123,721)	(\$1,021,119)	(\$918,518)	(\$815,917)	(\$713,315)	(\$610,714)	(\$508,112)	(\$405,511)	(\$302,910)	(\$200,308)

Table I-10. Pickup Trucks (4x2): Sensitivity Analysis #5

Question: Holding all variables constant, if the USMC wants to either increase or decrease its inventory of AFV pickup truck 4x2s (based on current fleet size), what is the corresponding increase or decrease in fleet size that will shift the preferred alternative between leasing and purchasing?												
Findings: The USMC is indifferent to a decrease or increase in its pickup truck 4x2 inventory. As the table shows, the USMC can decrease its inventory by more than 70%, and purchasing would still be the preferred alternative. Likewise, as the USMC increases its inventory, purchasing remains the preferred alternative as cost savings increase with increases in inventory.												
		Total Inventory per Year—Lease										
Net Purchase	Change in NPV	-69%	-8.0%	-6.0%	-4.0%	-2.0%	0.0%	2.0%	4.0%	6.0%	8.0%	10.0%
Lease	\$2,467,461	\$764,913	\$2,270,065	\$2,319,414	\$2,368,763	\$2,418,112	\$2,467,461	\$2,516,811	\$2,566,160	\$2,615,509	\$2,664,858	\$2,714,208
Purchase	\$2,245,574	\$696,128	\$2,065,928	\$2,110,840	\$2,155,751	\$2,200,662	\$2,245,574	\$2,290,485	\$2,335,397	\$2,380,308	\$2,425,220	\$2,470,131
Net Purchase	\$221,887	\$68,785	\$204,136	\$208,574	\$213,012	\$217,450	\$221,887	\$226,325	\$230,763	\$235,201	\$239,638	\$244,076

Table I-11. Minivans: Sensitivity Analysis #1

Question: Given changes in depreciation, what are the corresponding changes in NPV between lease and purchase?												
Findings: Given the OMB's current (2009) discount rate of 2.3%, if a vehicle depreciates by less than 18%, then purchasing is the preferred alternative. If depreciation is more than 18%, then the vehicle will lose too much of its value to make purchasing worthwhile. Thus, leasing is the preferred alternative. However, given historical data, a vehicle usually depreciates as much as 20-25% after the first year and roughly 18-20% every year after. Given these historical depreciation rates, it will be difficult to judge the best alternative solely based on depreciation or salvage value since the breakeven point for depreciation is so close to the observed rates over time.												
	Change in NPV	Depreciation Factor as a Percentage of Purchase Price										
		15.0%	16.0%	17.0%	18.0%	19.0%	20.0%	21.0%	22.0%	23.0%	24.0%	25.0%
Lease	\$3,183,985	\$3,183,985	\$3,183,985	\$3,183,985	\$3,183,985	\$3,183,985	\$3,183,985	\$3,183,985	\$3,183,985	\$3,183,985	\$3,183,985	\$3,183,985
Purchase	\$4,003,238	\$2,763,570	\$2,902,153	\$3,037,250	\$3,168,954	\$3,297,356	\$3,422,543	\$3,544,604	\$3,663,622	\$3,779,681	\$3,892,860	\$4,003,238
Net Purchase	-\$819,253	\$420,416	\$281,832	\$146,735	\$15,031	(\$113,371)	(\$238,558)	(\$360,619)	(\$479,637)	(\$595,696)	(\$708,875)	(\$819,253)

Table I-12. Minivans: Sensitivity Analysis #2

Question: Given changes in depreciation and the discount rate, what are the corresponding changes in NPV between lease and purchase?												
Discount Rate		Depreciation Factor as a Percentage of Purchase Price										
Net Purchase	-\$819,253	15.0%	16.0%	17.0%	18.0%	19.0%	20.0%	21.0%	22.0%	23.0%	24.0%	25.0%
Discount Rate	0.0%	\$822,311	\$663,469	\$508,623	\$357,667	\$210,495	\$67,007	(\$72,897)	(\$209,313)	(\$342,338)	(\$472,061)	(\$598,575)
	0.1%	\$803,118	\$645,226	\$491,306	\$341,251	\$194,960	\$52,330	(\$86,738)	(\$222,339)	(\$354,567)	(\$483,516)	(\$609,273)
	0.2%	\$784,091	\$627,142	\$474,141	\$324,983	\$179,565	\$37,787	(\$100,450)	(\$235,241)	(\$366,680)	(\$494,858)	(\$619,864)
	0.3%	\$765,228	\$609,215	\$457,128	\$308,860	\$164,310	\$23,378	(\$114,034)	(\$248,021)	(\$378,676)	(\$506,089)	(\$630,349)
	0.4%	\$746,529	\$591,446	\$440,265	\$292,881	\$149,192	\$9,100	(\$127,492)	(\$260,680)	(\$390,556)	(\$517,210)	(\$640,729)
	0.5%	\$727,991	\$573,832	\$423,551	\$277,045	\$134,212	(\$5,046)	(\$140,825)	(\$273,220)	(\$402,322)	(\$528,221)	(\$651,005)
	0.6%	\$709,613	\$556,372	\$406,985	\$261,350	\$119,367	(\$19,062)	(\$154,033)	(\$285,641)	(\$413,975)	(\$539,125)	(\$661,178)
	0.7%	\$691,395	\$539,064	\$390,565	\$245,796	\$104,657	(\$32,950)	(\$167,119)	(\$297,944)	(\$425,515)	(\$549,922)	(\$671,250)
	0.8%	\$673,334	\$521,907	\$374,290	\$230,381	\$90,080	(\$46,710)	(\$180,082)	(\$310,130)	(\$436,944)	(\$560,612)	(\$681,220)
	0.9%	\$655,429	\$504,901	\$358,159	\$215,104	\$75,635	(\$60,343)	(\$192,925)	(\$322,201)	(\$448,263)	(\$571,197)	(\$691,089)
	1.0%	\$637,679	\$488,043	\$342,171	\$199,963	\$61,321	(\$73,852)	(\$205,647)	(\$334,158)	(\$459,473)	(\$581,678)	(\$700,860)
	1.1%	\$620,083	\$471,332	\$326,324	\$184,958	\$47,136	(\$87,236)	(\$218,251)	(\$346,001)	(\$470,574)	(\$592,056)	(\$710,532)
	1.2%	\$602,638	\$454,768	\$310,617	\$170,087	\$33,080	(\$100,497)	(\$230,738)	(\$357,732)	(\$481,568)	(\$602,332)	(\$720,107)
	1.3%	\$585,345	\$438,347	\$295,048	\$155,349	\$19,152	(\$113,636)	(\$243,108)	(\$369,352)	(\$492,456)	(\$612,506)	(\$729,586)
	1.4%	\$568,200	\$422,071	\$279,618	\$140,742	\$5,349	(\$126,655)	(\$255,362)	(\$380,861)	(\$503,238)	(\$622,580)	(\$738,968)
	1.5%	\$551,204	\$405,936	\$264,323	\$126,267	(\$8,328)	(\$139,554)	(\$267,502)	(\$392,260)	(\$513,916)	(\$632,554)	(\$748,257)
	1.6%	\$534,355	\$389,943	\$249,164	\$111,921	(\$21,881)	(\$152,334)	(\$279,528)	(\$403,552)	(\$524,491)	(\$642,430)	(\$757,451)
	1.7%	\$517,651	\$374,089	\$234,139	\$97,703	(\$35,311)	(\$164,996)	(\$291,442)	(\$414,736)	(\$534,963)	(\$652,208)	(\$766,552)
	1.8%	\$501,092	\$358,374	\$219,246	\$83,613	(\$48,619)	(\$177,542)	(\$303,244)	(\$425,813)	(\$545,334)	(\$661,890)	(\$775,561)
	1.9%	\$484,675	\$342,796	\$204,485	\$69,649	(\$61,807)	(\$189,972)	(\$314,936)	(\$436,785)	(\$555,604)	(\$671,475)	(\$784,479)
	2.0%	\$468,401	\$327,354	\$189,855	\$55,810	(\$74,875)	(\$202,288)	(\$326,519)	(\$447,653)	(\$565,774)	(\$680,965)	(\$793,306)
	2.1%	\$452,267	\$312,046	\$175,354	\$42,094	(\$87,824)	(\$214,490)	(\$337,993)	(\$458,417)	(\$575,846)	(\$690,361)	(\$802,043)
	2.2%	\$436,272	\$296,873	\$160,981	\$28,502	(\$100,655)	(\$226,580)	(\$349,359)	(\$469,078)	(\$585,819)	(\$699,664)	(\$810,692)
	2.3%	\$420,416	\$281,832	\$146,735	\$15,031	(\$113,371)	(\$238,558)	(\$360,619)	(\$479,637)	(\$595,696)	(\$708,875)	(\$819,253)
	2.4%	\$404,696	\$266,922	\$132,615	\$1,681	(\$125,970)	(\$250,426)	(\$371,773)	(\$490,096)	(\$605,476)	(\$717,994)	(\$827,727)
	2.5%	\$389,112	\$252,143	\$118,620	(\$11,550)	(\$138,455)	(\$262,185)	(\$382,823)	(\$500,455)	(\$615,161)	(\$727,022)	(\$836,114)
	2.6%	\$373,663	\$237,493	\$104,749	(\$24,662)	(\$150,827)	(\$273,834)	(\$393,769)	(\$510,715)	(\$624,752)	(\$735,960)	(\$844,416)
	2.7%	\$358,347	\$222,971	\$91,000	(\$37,656)	(\$163,086)	(\$285,377)	(\$404,612)	(\$520,876)	(\$634,249)	(\$744,809)	(\$852,632)
	2.8%	\$343,163	\$208,575	\$77,373	(\$50,534)	(\$175,234)	(\$296,812)	(\$415,354)	(\$530,941)	(\$643,653)	(\$753,569)	(\$860,765)
	2.9%	\$328,111	\$194,305	\$63,866	(\$63,296)	(\$187,271)	(\$308,142)	(\$425,994)	(\$540,909)	(\$652,966)	(\$762,242)	(\$868,815)
	3.0%	\$313,188	\$180,160	\$50,479	(\$75,945)	(\$199,198)	(\$319,367)	(\$436,535)	(\$550,781)	(\$662,187)	(\$770,829)	(\$876,782)
	3.1%	\$298,394	\$166,139	\$37,211	(\$88,479)	(\$211,017)	(\$330,489)	(\$446,976)	(\$560,559)	(\$671,318)	(\$779,329)	(\$884,667)
	3.2%	\$283,728	\$152,240	\$24,060	(\$100,901)	(\$222,729)	(\$341,507)	(\$457,319)	(\$570,244)	(\$680,360)	(\$787,744)	(\$892,472)
	3.3%	\$269,189	\$138,463	\$11,025	(\$113,212)	(\$234,334)	(\$352,424)	(\$467,564)	(\$579,835)	(\$689,313)	(\$796,075)	(\$900,196)
	3.4%	\$254,775	\$124,806	(\$1,894)	(\$125,412)	(\$245,833)	(\$363,239)	(\$477,713)	(\$589,334)	(\$698,178)	(\$804,323)	(\$907,840)

3.5%	\$240,486	\$111,268	(\$14,699)	(\$137,503)	(\$257,227)	(\$373,955)	(\$487,767)	(\$598,742)	(\$706,957)	(\$812,487)	(\$915,406)
3.6%	\$226,320	\$97,849	(\$27,391)	(\$149,485)	(\$268,517)	(\$384,571)	(\$497,725)	(\$608,059)	(\$715,649)	(\$820,569)	(\$922,894)
3.7%	\$212,276	\$84,546	(\$39,970)	(\$161,359)	(\$279,705)	(\$395,088)	(\$507,589)	(\$617,286)	(\$724,255)	(\$828,570)	(\$930,304)
3.8%	\$198,354	\$71,361	(\$52,438)	(\$173,127)	(\$290,790)	(\$405,508)	(\$517,361)	(\$626,425)	(\$732,777)	(\$836,491)	(\$937,638)
3.9%	\$184,552	\$58,290	(\$64,795)	(\$184,789)	(\$301,774)	(\$415,831)	(\$527,040)	(\$635,476)	(\$741,215)	(\$844,331)	(\$944,896)
4.0%	\$170,869	\$45,334	(\$77,043)	(\$196,346)	(\$312,658)	(\$426,059)	(\$536,627)	(\$644,439)	(\$749,570)	(\$852,093)	(\$952,078)
4.1%	\$157,304	\$32,491	(\$89,182)	(\$207,800)	(\$323,443)	(\$436,191)	(\$546,124)	(\$653,316)	(\$757,842)	(\$859,775)	(\$959,186)
4.2%	\$143,857	\$19,760	(\$101,214)	(\$219,150)	(\$334,129)	(\$446,230)	(\$555,531)	(\$662,107)	(\$766,033)	(\$867,381)	(\$966,220)
4.3%	\$130,525	\$7,141	(\$113,139)	(\$230,398)	(\$344,717)	(\$456,175)	(\$564,848)	(\$670,813)	(\$774,143)	(\$874,909)	(\$973,181)
4.4%	\$117,309	(\$5,368)	(\$124,958)	(\$241,545)	(\$355,209)	(\$46 6,027)	(\$574,078)	(\$679,435)	(\$782,172)	(\$882,360)	(\$980,069)
4.5%	\$104,207	(\$17,767)	(\$136,673)	(\$252,592)	(\$365,604)	(\$475,788)	(\$583,220)	(\$687,973)	(\$790,122)	(\$889,736)	(\$986,886)
4.6%	\$91,218	(\$30,058)	(\$148,283)	(\$263,539)	(\$375,905)	(\$485,458)	(\$592,275)	(\$696,429)	(\$797,993)	(\$897,037)	(\$993,631)
4.7%	\$78,341	(\$42,241)	(\$159,791)	(\$274,387)	(\$386,111)	(\$495,038)	(\$601,244)	(\$704,803)	(\$805,786)	(\$904,264)	(\$1,000,305)
4.8%	\$65,576	(\$54,318)	(\$171,196)	(\$285,138)	(\$396,223)	(\$504,528)	(\$610,128)	(\$713,095)	(\$813,502)	(\$911,417)	(\$1,006,910)
4.9%	\$52,921	(\$66,289)	(\$182,500)	(\$295,792)	(\$406,243)	(\$513,930)	(\$618,927)	(\$721,307)	(\$821,141)	(\$918,498)	(\$1,013,445)
5.0%	\$40,375	(\$78,155)	(\$193,703)	(\$306,350)	(\$416,171)	(\$523,244)	(\$627,643)	(\$729,439)	(\$828,704)	(\$925,506)	(\$1,019,912)
5.1%	\$27,938	(\$89,917)	(\$204,808)	(\$316,812)	(\$426,008)	(\$532,472)	(\$636,275)	(\$737,492)	(\$836,191)	(\$932,442)	(\$1,026,311)
5.2%	\$15,608	(\$101,576)	(\$215,813)	(\$327,180)	(\$435,755)	(\$541,613)	(\$644,826)	(\$745,466)	(\$843,604)	(\$939,307)	(\$1,032,642)
5.3%	\$3,385	(\$113,133)	(\$226,721)	(\$337,455)	(\$445,413)	(\$550,668)	(\$653,295)	(\$753,363)	(\$850,943)	(\$946,102)	(\$1,038,906)
5.4%	(\$8,732)	(\$124,589)	(\$237,531)	(\$347,637)	(\$454,981)	(\$559,639)	(\$661,683)	(\$761,183)	(\$858,209)	(\$952,827)	(\$1,045,104)
5.5%	(\$20,745)	(\$135,944)	(\$248,246)	(\$357,726)	(\$464,462)	(\$568,526)	(\$669,991)	(\$768,926)	(\$865,401)	(\$959,483)	(\$1,051,237)
5.6%	(\$32,653)	(\$147,200)	(\$258,865)	(\$367,725)	(\$473,855)	(\$577,330)	(\$678,219)	(\$776,594)	(\$872,522)	(\$966,071)	(\$1,057,304)
5.7%	(\$44,459)	(\$158,357)	(\$269,389)	(\$377,633)	(\$483,163)	(\$586,051)	(\$686,369)	(\$784,187)	(\$879,572)	(\$972,590)	(\$1,063,307)
5.8%	(\$56,163)	(\$169,416)	(\$279,820)	(\$387,452)	(\$492,384)	(\$594,690)	(\$694,441)	(\$791,705)	(\$886,551)	(\$979,043)	(\$1,069,246)
5.9%	(\$67,765)	(\$180,378)	(\$290,158)	(\$397,181)	(\$501,521)	(\$603,248)	(\$702,435)	(\$799,150)	(\$893,459)	(\$985,429)	(\$1,075,122)
6.0%	(\$79,267)	(\$191,244)	(\$300,404)	(\$406,823)	(\$510,573)	(\$611,726)	(\$710,353)	(\$806,521)	(\$900,298)	(\$991,748)	(\$1,080,936)
6.1%	(\$90,669)	(\$202,014)	(\$310,559)	(\$416,377)	(\$519,542)	(\$620,125)	(\$718,195)	(\$813,821)	(\$907,068)	(\$998,003)	(\$1,086,687)
6.2%	(\$101,972)	(\$212,690)	(\$320,623)	(\$425,845)	(\$528,428)	(\$628,444)	(\$725,961)	(\$821,048)	(\$913,770)	(\$1,004,192)	(\$1,092,376)
6.3%	(\$113,178)	(\$223,273)	(\$330,597)	(\$435,227)	(\$537,232)	(\$636,685)	(\$733,653)	(\$828,205)	(\$920,405)	(\$1,010,317)	(\$1,098,005)
6.4%	(\$124,287)	(\$233,762)	(\$340,483)	(\$444,523)	(\$545,955)	(\$644,848)	(\$741,271)	(\$835,291)	(\$926,972)	(\$1,016,379)	(\$1,103,573)
6.5%	(\$135,299)	(\$244,159)	(\$350,280)	(\$453,736)	(\$554,598)	(\$652,935)	(\$748,816)	(\$842,307)	(\$933,473)	(\$1,022,377)	(\$1,109,081)
6.6%	(\$146,216)	(\$254,464)	(\$359,990)	(\$462,865)	(\$563,160)	(\$660,945)	(\$756,288)	(\$849,254)	(\$939,908)	(\$1,028,313)	(\$1,114,530)
6.7%	(\$157,038)	(\$264,679)	(\$369,613)	(\$471,911)	(\$571,643)	(\$668,880)	(\$763,687)	(\$856,132)	(\$946,277)	(\$1,034,186)	(\$1,119,920)
6.8%	(\$167,767)	(\$274,805)	(\$379,150)	(\$480,874)	(\$580,048)	(\$676,739)	(\$771,016)	(\$862,942)	(\$952,582)	(\$1,039,998)	(\$1,125,251)
6.9%	(\$178,402)	(\$284,841)	(\$388,602)	(\$489,756)	(\$588,375)	(\$684,525)	(\$778,273)	(\$869,685)	(\$958,823)	(\$1,045,750)	(\$1,130,525)
7.0%	(\$188,945)	(\$294,788)	(\$397,969)	(\$498,558)	(\$596,624)	(\$692,237)	(\$785,460)	(\$876,361)	(\$965,000)	(\$1,051,441)	(\$1,135,742)

Table I-13. Minivans: Sensitivity Analysis #3

Question: Given changes in incremental costs of both leased and purchased vehicles (both have differing values), what are the corresponding changes in NPV between lease and purchase?												
Findings: When the incremental cost of leasing and purchasing remain the same, leasing is the preferred alternative. However, once the incremental cost to lease increases to \$1,750, and the incremental cost to purchase remains the same, then purchasing becomes the preferred alternative. Additionally, for every \$250 increase over \$1,750 in the incremental cost to lease, the incremental cost to purchase can increase \$500, and purchasing will still remain the preferred alternative.												
		Incremental Cost—Lease										
Net Purchase	-\$819,253	\$0	\$250	\$500	\$750	\$1,000	\$1,250	\$1,500	\$1,750	\$2,000	\$2,250	\$2,500
Incremental Cost —Purchase	\$0	(\$735,301)	(\$622,214)	(\$509,126)	(\$396,038)	(\$282,950)	(\$169,862)	(\$56,774)	\$56,314	\$169,401	\$282,489	\$395,577
	\$250	(\$793,123)	(\$680,035)	(\$566,947)	(\$453,860)	(\$340,772)	(\$227,684)	(\$114,596)	(\$1,508)	\$111,580	\$224,668	\$337,755
	\$500	(\$850,945)	(\$737,857)	(\$624,769)	(\$511,681)	(\$398,593)	(\$285,506)	(\$172,418)	(\$59,330)	\$53,758	\$166,846	\$279,934
	\$750	(\$908,767)	(\$795,679)	(\$682,591)	(\$569,503)	(\$456,415)	(\$343,327)	(\$230,239)	(\$117,152)	(\$4,064)	\$109,024	\$222,112
	\$1,000	(\$966,588)	(\$853,500)	(\$740,413)	(\$627,325)	(\$514,237)	(\$401,149)	(\$288,061)	(\$174,973)	(\$61,885)	\$51,202	\$164,290
	\$1,250	(\$1,024,410)	(\$911,322)	(\$798,234)	(\$685,146)	(\$572,059)	(\$458,971)	(\$345,883)	(\$232,795)	(\$119,707)	(\$6,619)	\$106,469
	\$1,500	(\$1,082,232)	(\$969,144)	(\$856,056)	(\$742,968)	(\$629,880)	(\$516,792)	(\$403,705)	(\$290,617)	(\$177,529)	(\$64,441)	\$48,647
	\$1,750	(\$1,140,053)	(\$1,026,965)	(\$913,878)	(\$800,790)	(\$687,702)	(\$574,614)	(\$461,526)	(\$348,438)	(\$235,351)	(\$122,263)	(\$9,175)
	\$2,000	(\$1,197,875)	(\$1,084,787)	(\$971,699)	(\$858,611)	(\$745,524)	(\$632,436)	(\$519,348)	(\$406,260)	(\$293,172)	(\$180,084)	(\$66,997)
	\$2,250	(\$1,255,697)	(\$1,142,609)	(\$1,029,521)	(\$916,433)	(\$803,345)	(\$690,257)	(\$577,170)	(\$464,082)	(\$350,994)	(\$237,906)	(\$124,818)
	\$2,500	(\$1,313,518)	(\$1,200,431)	(\$1,087,343)	(\$974,255)	(\$861,167)	(\$748,079)	(\$634,991)	(\$521,903)	(\$408,816)	(\$295,728)	(\$182,640)
	\$2,750	(\$1,371,340)	(\$1,258,252)	(\$1,145,164)	(\$1,032,077)	(\$918,989)	(\$805,901)	(\$692,813)	(\$579,725)	(\$466,637)	(\$353,549)	(\$240,462)
	\$3,000	(\$1,429,162)	(\$1,316,074)	(\$1,202,986)	(\$1,089,898)	(\$976,810)	(\$863,723)	(\$750,635)	(\$637,547)	(\$524,459)	(\$411,371)	(\$298,283)
	\$3,250	(\$1,486,983)	(\$1,373,896)	(\$1,260,808)	(\$1,147,720)	(\$1,034,632)	(\$921,544)	(\$808,456)	(\$695,369)	(\$582,281)	(\$469,193)	(\$356,105)
	\$3,500	(\$1,544,805)	(\$1,431,717)	(\$1,318,629)	(\$1,205,542)	(\$1,092,454)	(\$979,366)	(\$866,278)	(\$753,190)	(\$640,102)	(\$527,015)	(\$413,927)
	\$3,750	(\$1,602,627)	(\$1,489,539)	(\$1,376,451)	(\$1,263,363)	(\$1,150,275)	(\$1,037,188)	(\$924,100)	(\$811,012)	(\$697,924)	(\$584,836)	(\$471,748)
	\$4,000	(\$1,660,449)	(\$1,547,361)	(\$1,434,273)	(\$1,321,185)	(\$1,208,097)	(\$1,095,009)	(\$981,921)	(\$868,834)	(\$755,746)	(\$642,658)	(\$529,570)
	\$4,250	(\$1,718,270)	(\$1,605,182)	(\$1,492,095)	(\$1,379,007)	(\$1,265,919)	(\$1,152,831)	(\$1,039,743)	(\$926,655)	(\$813,567)	(\$700,480)	(\$587,392)
	\$4,500	(\$1,776,092)	(\$1,663,004)	(\$1,549,916)	(\$1,436,828)	(\$1,323,741)	(\$1,210,653)	(\$1,097,565)	(\$984,477)	(\$871,389)	(\$758,301)	(\$645,213)
	\$4,750	(\$1,833,914)	(\$1,720,826)	(\$1,607,738)	(\$1,494,650)	(\$1,381,562)	(\$1,268,474)	(\$1,155,387)	(\$1,042,299)	(\$929,211)	(\$816,123)	(\$703,035)
	\$5,000	(\$1,891,735)	(\$1,778,648)	(\$1,665,560)	(\$1,552,472)	(\$1,439,384)	(\$1,326,296)	(\$1,213,208)	(\$1,100,120)	(\$987,033)	(\$873,945)	(\$760,857)
	\$5,250	(\$1,949,557)	(\$1,836,469)	(\$1,723,381)	(\$1,610,294)	(\$1,497,206)	(\$1,384,118)	(\$1,271,030)	(\$1,157,942)	(\$1,044,854)	(\$931,766)	(\$818,679)
	\$5,500	(\$2,007,379)	(\$1,894,291)	(\$1,781,203)	(\$1,668,115)	(\$1,555,027)	(\$1,441,940)	(\$1,328,852)	(\$1,215,764)	(\$1,102,676)	(\$989,588)	(\$876,500)
	\$5,750	(\$2,065,200)	(\$1,952,113)	(\$1,839,025)	(\$1,725,937)	(\$1,612,849)	(\$1,499,761)	(\$1,386,673)	(\$1,273,586)	(\$1,160,498)	(\$1,047,410)	(\$934,322)
	\$6,000	(\$2,123,022)	(\$2,009,934)	(\$1,896,846)	(\$1,783,759)	(\$1,670,671)	(\$1,557,583)	(\$1,444,495)	(\$1,331,407)	(\$1,218,319)	(\$1,105,232)	(\$992,144)

Table I-14. Minivans: Sensitivity Analysis #4

Question: Given changes in monthly lease rate and the purchase price, what are the corresponding changes in NPV between lease and purchase?												
Findings: If the monthly lease rate and the purchase price remain constant, then leasing is the preferred alternative. If the lease rate stays the same, the purchase price must decrease by more than 30% for purchasing to be the preferred alternative; otherwise, leasing is the preferred alternative. If the purchase price remains the same, the lease rate must increase by more than 30% for purchasing to be the preferred alternative; otherwise, leasing is the preferred alternative.												
		Monthly Lease Rate										
Net Purchase	-\$819,253	-50%	-40%	-30%	-20%	-10%	0%	10%	20%	30%	40%	50%
Purchase Price	-50%	(\$451,602)	(\$139,471)	\$172,660	\$484,791	\$796,923	\$1,109,054	\$1,421,185	\$1,733,316	\$2,045,448	\$2,357,579	\$2,669,710
	-40%	(\$837,264)	(\$525,132)	(\$213,001)	\$99,130	\$411,261	\$723,392	\$1,035,524	\$1,347,655	\$1,659,786	\$1,971,917	\$2,284,049
	-30%	(\$1,222,925)	(\$910,794)	(\$598,663)	(\$286,531)	\$25,600	\$337,731	\$649,862	\$961,994	\$1,274,125	\$1,586,256	\$1,898,387
	-20%	(\$1,608,586)	(\$1,296,455)	(\$984,324)	(\$672,193)	(\$360,062)	(\$47,930)	\$264,201	\$576,332	\$888,463	\$1,200,595	\$1,512,726
	-10%	(\$1,994,248)	(\$1,682,117)	(\$1,369,985)	(\$1,057,854)	(\$745,723)	(\$433,592)	(\$121,460)	\$190,671	\$502,802	\$814,933	\$1,127,065
	0%	(\$2,379,909)	(\$2,067,778)	(\$1,755,647)	(\$1,443,515)	(\$1,131,384)	(\$819,253)	(\$507,122)	(\$194,991)	\$117,141	\$429,272	\$741,403
	10%	(\$2,765,571)	(\$2,453,439)	(\$2,141,308)	(\$1,829,177)	(\$1,517,046)	(\$1,204,914)	(\$892,783)	(\$580,652)	(\$268,521)	\$43,611	\$355,742
	20%	(\$3,151,232)	(\$2,839,101)	(\$2,526,969)	(\$2,214,838)	(\$1,902,707)	(\$1,590,576)	(\$1,278,445)	(\$966,313)	(\$654,182)	(\$342,051)	(\$29,920)
	30%	(\$3,536,893)	(\$3,224,762)	(\$2,912,631)	(\$2,600,500)	(\$2,288,368)	(\$1,976,237)	(\$1,664,106)	(\$1,351,975)	(\$1,039,843)	(\$727,712)	(\$415,581)
	40%	(\$3,922,555)	(\$3,610,423)	(\$3,298,292)	(\$2,986,161)	(\$2,674,030)	(\$2,361,899)	(\$2,049,767)	(\$1,737,636)	(\$1,425,505)	(\$1,113,374)	(\$801,242)
	50%	(\$4,308,216)	(\$3,996,085)	(\$3,683,954)	(\$3,371,822)	(\$3,059,691)	(\$2,747,560)	(\$2,435,429)	(\$2,123,297)	(\$1,811,166)	(\$1,499,035)	(\$1,186,904)

Table I-15. Minivans: Sensitivity Analysis #5

Question: Holding all variables constant, if the Marine Corps wants to either increase or decrease its inventory of AFV minivans (based on current fleet size), what is the corresponding increase or decrease in fleet size that will shift the preferred alternative between leasing and purchasing?												
Findings: The USMC is indifferent to a decrease or increase in its minivan inventory. As the table shows, the USMC can increase or decrease its minivan inventory almost as much as it wants as leasing will still remain the preferred alternative.												
Net Purchase	Change in NPV	Total Inventory per Year—Lease										
		-60%	-50%	-40%	-30%	-20%	-10%	0%	10%	20%	30%	40%
Lease	\$3,183,985	\$1,273,594	\$1,591,993	\$1,910,391	\$2,228,790	\$2,547,188	\$2,865,587	\$3,183,985	\$3,502,384	\$3,820,782	\$4,139,181	\$4,457,579
Purchase	\$4,003,238	\$1,601,295	\$2,001,619	\$2,401,943	\$2,802,267	\$3,202,591	\$3,602,914	\$4,003,238	\$4,403,562	\$4,803,886	\$5,204,210	\$5,604,533
Net Purchase	-\$819,253	(\$327,701)	(\$409,627)	(\$491,552)	(\$573,477)	(\$655,402)	(\$737,328)	(\$819,253)	(\$901,178)	(\$983,104)	(\$1,065,029)	(\$1,146,954)

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